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## THE ODDS OF CRIMINAL JUSTICE IN GEORGIA: MATHEMATICALLY EXPRESSED PROBABILITIES IN GEORGIA CRIMINAL TRIALS

In 1982, a Georgia jury found Wayne Williams guilty of the murders of two young men.<sup>1</sup> The prosecution's case relied heavily on the significance of certain "fiber evidence," evidence that fibers recovered from the victims' bodies were similar to fibers found in Williams' home and car.<sup>2</sup> The prosecution used mathematical calculations of probability, in expert testimony and in closing argument, to demonstrate the significance of the fibers' similarity.<sup>3</sup> On appeal, Williams contended that the expert testimony should not have been admitted and that the prosecutor's argument had been improper.<sup>4</sup> The Supreme Court of Georgia, however, in an opinion written by Justice Bell, rejected Williams' contentions with almost no comment.<sup>5</sup> Thus, whether the use of probabilities in evidence or in argument might ever be considered improper in a Georgia criminal trial remains an unanswered question.

This Note suggests that a need exists in Georgia for the articulation of standards regarding two related questions. First, when should evidence consisting of mathematically expressed probabilities be admissible in a criminal trial to prove a connection between the defendant and the charged offense? Second, what should be the scope of permissible use of mathematically expressed probabilities in the prosecution's closing argument? The majority

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1. See *Williams v. State*, 251 Ga. 749, 749, 312 S.E.2d 40, 48 (1983). On February 27, 1982, Williams was convicted of murdering Nathaniel Cater and Jimmy Ray Payne. *Id.* A motion for a new trial was denied on December 16, 1982. *Id.* The Supreme Court of Georgia affirmed the denial on December 5, 1983 (rehearing denied on January 18, 1984). *Id.* at 809, 312 S.E.2d at 40. Williams was sentenced to serve two consecutive life sentences. *Id.* at 749, 312 S.E.2d at 48.

2. Cf. *id.* at 821, 312 S.E.2d at 96 (Smith, J., dissenting) (noting the central role of fiber evidence in the Williams case).

3. See Transcript at 2285-91, 6881-83, File No. A-56186, *State v. Williams* (Fulton County Super. Ct. 1982) [hereinafter cited as Transcript]; *Williams*, 251 Ga. at 786, 312 S.E.2d at 72-73.

4. *Williams*, 251 Ga. at 786, 312 S.E.2d at 72.

5. See *id.* at 786, 312 S.E.2d at 72-73; *id.* at 821, 312 S.E.2d at 96 (Smith, J., dissenting).

opinion in *Williams v. State*<sup>6</sup> will be considered as an example of Georgia's current approach to these questions.

The concept of "probability" is related to many aspects of the legal process of fact finding. For example, in civil cases, determinations of fact are usually based on a preponderance of the evidence, a "more-probable-than-not" standard. In criminal cases, on the other hand, guilt must be proved "beyond a reasonable doubt," a standard which suggests that a very high probability of guilt must be established, although absolute certainty of guilt is not required. A jury's assessments of probability are usually arrived at in a nonmathematical way. Sometimes, however, the jury must consider probabilities expressed in mathematical terms. This Note is concerned only with the use in evidence and argument of those statements of probability which are herein termed "mathematically expressed probabilities."

As used in this Note, a "mathematically expressed probability" means either a statement which purports to quantify the probability of a certain event's occurrence or a statement which contains at least one numerical term implying such a quantified assessment of probability. Consider the following examples. The statement "It is quite likely that you have a talking dog" is *not* a mathematically expressed probability; no quantified assessment of probability is stated or implied. The statement "There is a seventy percent chance that your dog will speak" expresses a quantified assessment of probability and thus *is* a mathematically expressed probability. The purpose of this Note is to elucidate the potentially unfair use of such expressions of probability in criminal trials.

# I. THE ADMISSIBILITY OF MATHEMATICALLY EXPRESSED PROBABILITIES

During a criminal trial, the prosecution can present mathematically expressed probabilities to the jury either as evidence (often in the form of expert testimony) or during closing arguments. The focus of this section is the admissibility of such probabilities as evidence. This section examines generally the potentially prejudicial nature of expert assessments of probability and discusses specifically the expert testimony admitted in the Georgia murder trial of Wayne Williams.

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6. 251 Ga. 749, 312 S.E.2d 40 (1983).

A. *The Potential for Prejudice Inherent in Evidence of Mathematically Expressed Probabilities*

Evidence consisting of reliable mathematically expressed probabilities can sometimes help the fact finder by providing a reasoned basis for deciding whether a particular fact has been established.<sup>7</sup> Statistical interpretations of otherwise unmanageable collections of data can be particularly helpful.<sup>8</sup> For example, courts have considered what percentage of a community's population is made up of a certain ethnic group in determining the existence of bias in the community's jury selection process.<sup>9</sup> The usefulness of such statistical evidence will often depend on its being expressed in mathematical terms; an otherwise vague expert opinion may become clearer and more helpful if supported or illustrated by statistical evidence.<sup>10</sup>

Notwithstanding the usefulness of reliable probability evidence,<sup>11</sup> several jurisdictions have limited the admissibility of such evidence in criminal trials.<sup>12</sup> Probability evidence is often introduced through expert testimony because of the general rule prohibiting lay witnesses from stating opinions or inferences.<sup>13</sup> The

7. Cf. Reich, *How to Evaluate an Expert's Statistical Analysis*, 28 PRAC. LAW., Apr. 15, 1982, at 69, 69 (observing an increase in the use of statistical analysis to resolve factual issues); Note, *Statistics in the Law: Potential Problems in the Presentation of Statistical Evidence*, 40 WASH. & LEE L. REV. 313, 335-36 (1983) (noting the importance of statistical evidence in complex litigation or cases involving numerical measurement).

8. See Note, *supra* note 7, at 313, 336-37.

9. See, e.g., *Castaneda v. Partida*, 430 U.S. 482 (1977). Such a percentage is a mathematically expressed probability because the percentage implies the probability of the occurrence of an event. For example, the statement "Twenty-five percent of Green County's population consists of green people" implies that there is a 25% probability (i.e., a one-in-four chance) that a person chosen at random from the population of Green County will be green.

10. For example, an expert's opinion that "a significant number" of certain medical cases are fatal would be clarified by supporting statistics which show that 45% of those cases reported have proved fatal.

11. For convenience, the terms "probabilities," "probability evidence," and "probability testimony" are sometimes used in this Note to refer to statements of mathematically expressed probabilities.

12. See *United States v. Massey*, 594 F.2d 676 (8th Cir. 1979); *Miller v. State*, 240 Ark. 340, 399 S.W.2d 268 (1966); *People v. Collins*, 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968); *State v. Washington*, 229 Kan. 47, 622 P.2d 986 (1981); *Commonwealth v. Drayton*, 386 Mass. 39, 434 N.E.2d 997 (1982); *State v. Boyd*, 331 N.W.2d 480 (Minn. 1983); *State v. Carlson*, 267 N.W.2d 170 (Minn. 1978); *State v. Sneed*, 76 N.M. 349, 414 P.2d 858 (Sup. Ct. 1966); *People v. Risley*, 214 N.Y. 75, 108 N.E. 200 (1915).

13. Cf. Fed. R. Evid. 701; O.C.G.A. § 24-9-65 (1982) (limiting admissibility of opinion testimony generally); Fed. R. Evid. 702; O.C.G.A. § 24-9-67 (1982) (permitting ex-

evidentiary rules governing expert opinions have sometimes been applied in finding certain mathematically expressed probabilities inadmissible.<sup>14</sup> Other courts have indicated that probability testimony should be inadmissible unless the specific methodology underlying the expert's opinion has been proven valid or reliable.<sup>15</sup>

pert opinion testimony).

14. Expert probability testimony might be excluded because: the witness is not competent as an expert to testify about mathematically expressed probabilities, *cf.* Commonwealth v. Drayton, 386 Mass. 39, 49-51, 434 N.E.2d 997, 1005-06 (1982) (fingerprint expert's testimony regarding probability of criminal identification erroneously admitted because not accompanied by expert explanation of underlying calculations); the expert's opinion is based on sheer conjecture, *see* Miller v. State, 240 Ark. 340, 343-44, 399 S.W.2d 268, 270 (1966); the expert's opinion is based on another expert's opinion, *see* People v. Collins, 43 Mich. App. 259, 268, 204 N.W.2d 290, 295 (1972); or the expert's opinion is based on other sources of information not presented to the jury, *cf.* Stewart v. State, 246 Ga. 70, 75-76, 268 S.E.2d 906, 912 (1980) (erroneous admission of testimony based on nonprobabilistic mathematical calculations).

15. *Cf.* Miller v. State, 240 Ark. 340, 343-44, 399 S.W.2d 268, 270 (1966) (finding error in admission of "unsubstantiated, speculative testimony on probabilities"); State v. Sneed, 76 N.M. 349, 354, 414 P.2d 858, 862 (Sup. Ct. 1966) (holding probability evidence inadmissible "to identify a defendant in a criminal proceeding so long as the odds are based on estimates, the validity of which have [sic] not been demonstrated").

Consider the following example of a statistically invalid procedure used in People v. Collins, 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968). The prosecutor assigned estimated probabilities of randomly selecting people who share certain characteristics with the supposed perpetrators of a robbery. The characteristics and the assigned probabilities that a person would possess the characteristics were as follows:

<u>Characteristic</u>	<u>Individual Probability</u>
A. Partly yellow automobile	1/10
B. Man with mustache	1/4
C. Girl with ponytail	1/10
D. Girl with blond hair	1/3
E. Negro man with beard	1/10
F. Interracial couple in car	1/1000

*Id.* at 325 n.10, 438 P.2d at 37 n.10, 66 Cal. Rptr. at 501 n.10.

The prosecutor argued that, according to the "product rule" testified to by a mathematics expert, the odds of a particular couple possessing all the characteristics equaled the product of all the individual probabilities, or 1/12,000,000 (one in twelve million). Because the defendants possessed all the characteristics on the list, "it was to be inferred that there could be but one chance in 12 million that defendants were innocent . . . ." *Id.* at 325, 438 P.2d at 37, 66 Cal. Rptr. at 501.

The "product rule" can be used properly to determine the odds of multiple events occurring in combination. For example, in a random selection of one playing card from a deck of 52 cards, there is a 1/52 chance of selecting the two of diamonds. The probability that the two of diamonds would be selected twice in only two trials is 1/52 multiplied by 1/52, which equals 1/2,704. *See id.* at 325 & n.8, 438 P.2d at 36 & n.8, 66 Cal. Rptr. at 500 & n.8. However, this simple "product rule" is only valid when the multiple events are independent of one another. Because the Collins prosecution never demonstrated the independence of the characteristics used in its calculations, the court found the method of calculation to be statistically invalid. *See id.* at 328-29, 438 P.2d at 39, 66 Cal. Rptr. at 503.

Such a required showing of reliable statistical procedure is analogous to the judicial tests used to determine the admissibility of other evidence based on unfamiliar scientific principles or procedures.<sup>16</sup> The primary concern, however, of the courts which have considered the admissibility of mathematically expressed probabilities has been the unfairly prejudicial effect on a jury of incompetent or unreliable probability testimony.

Some courts have indicated that a jury might be unable to assess properly the significance of mathematically expressed probabilities in relation to other evidence of guilt or innocence.<sup>17</sup> If the jurors do not understand the mathematical basis of the expert's opinion, they will not know how much weight to give the expert's testimony.<sup>18</sup> Even when probability evidence is substantiated and scientifically sound, the expert's opinion is still a mathematical expression whose ramifications the jury might not be able to understand completely.<sup>19</sup> Although a jury might similarly be mystified by the technical details underlying other types of expert testimony, there is a greater potential for prejudicial confusion and distraction inherent in the use of mathematically expressed probabilities.<sup>20</sup>

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16. In *Miller and Sneed*, the courts treated speculative probability evidence as analogous to evidence based on unverified scientific principles. See *Miller*, 240 Ark. at 344, 399 S.W.2d at 270; *Sneed*, 76 N.M. at 353-54, 414 P.2d at 861-62.

The test in many jurisdictions for the admissibility of evidence based on scientific principles originated in *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923). Under *Frye*, scientific evidence is admissible only when the principle on which it is based is "sufficiently established to have gained general acceptance in the particular field in which it belongs." *Frye*, 293 F. at 1014. See also *United States v. Brown*, 557 F.2d 541, 556 (6th Cir. 1977). The Supreme Court of Georgia, however, has explicitly rejected the *Frye* rule, stating that "'counting heads' in the scientific community is not an appropriate way to determine the admissibility of a scientific procedure . . ." *Harper v. State*, 249 Ga. 519, 525, 292 S.E.2d 389, 395 (1982). The *Harper* court held that the trial judge must determine "whether the procedure or technique in question has reached a scientific stage of verifiable certainty, . . . whether the procedure 'rests upon the laws of nature.'" *Id.* (quoting I. Younger, *Lectures on Evidence*, Nat'l Prac. Inst., Continuing Professional Education Lectures Series (1980)). The trial judge is authorized, under *Harper*, to base the determination on any of four specified factors: (1) evidence presented at trial, including expert testimony; (2) exhibits; (3) treatises; or (4) the rationale of cases in other jurisdictions. See *id.*

17. See *Collins*, 68 Cal. 2d at 332, 438 P.2d at 41, 66 Cal. Rptr. at 505; *State v. Carlson*, 267 N.W.2d 170, 176 (Minn. 1978).

18. See *Collins*, 68 Cal. 2d at 330-31, 438 P.2d at 40-41, 66 Cal. Rptr. at 504-05.

19. See *Carlson*, 267 N.W.2d at 176; cf. *United States ex rel. DiGiacomo v. Franzen*, 680 F.2d 515, 518 (7th Cir. 1982) (expressing concern about jury comprehension and confusion, although finding no violation of defendant's right to a fair trial).

20. See *infra* text, section III for further discussion of difficulties peculiar to mathematically expressed probabilities.

Consider the following hypothetical example. *X* is on trial for the murder of *Y*. There were no eyewitnesses to the killing, but police discovered an imprint made by a very rare style of shoe at the crime scene. The prosecution's expert testifies that only 200 pairs of shoes have been sold in the United States which could match the imprint found at the crime scene. The expert testifies that the probability of choosing a person in the United States at random who has a similar pair of shoes is about 200/200,000,000 or one in a million. *X* has a pair of shoes which matches the imprint. *X* also has a blood type which he shares with only ten percent of the United States populace. Blood of the same type was found on and near *Y*'s body, although *Y* had a different blood type. The expert testifies that the probability of randomly choosing a person who has the same blood type as *X* and who also has a similar pair of shoes is  $1/10$  multiplied by 1,000,000, which equals 1/10,000,000. Even if the expert's calculation were correct,<sup>21</sup> what should the jury do with the information? The significance of the odds in relation to the issue of *X*'s guilt is uncertain, although such a mathematical demonstration might convince some jurors that *X* is a murderer, especially after repeated references to "one in ten million" by the prosecutor.

Logically, however, *X*'s guilt is far from proved by the odds alone. First, there is no evidence that the shoe imprint and the blood were left by the same person. Second, there is no evidence that either the blood or the imprint was left by *Y*'s killer. Third, the odds themselves (one in ten million) indicate that out of 200,000,000 people in the United States, one might expect that twenty people have the same kind of blood and shoes as *X*. There is no evidence indicating that *X* is more likely the killer than any other person with the same kind of shoes and blood type. The point of this example is that a juror unfamiliar with statistical interpretation might be incapable of determining the significance which should be attached to mathematically expressed probabilities.

One aspect of probability evidence which increases its potential prejudicial effect is that effective cross-examination may be impossible, either because of the limited scientific knowledge of defense counsel or because of a hidden bias in the expert's method of cal-

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21. The calculation is not correct, in fact. It does not account for similar shoes sold outside the United States, it relies on an *estimated* 200 million population, and it relies on an *assumption* that each purchaser bought only one pair of similar shoes.

culatation.<sup>22</sup> Cross-examination to reveal bias or methodological flaws might be difficult whenever any scientific expert testifies, but the risk of resulting prejudice is greater when the expert is giving probability testimony. Because laymen are acquainted with the general concepts of "odds" and "chances," the risk is greater that a juror might accept an expert's assessment of probability merely because "it sounds right" or because of the juror's vague belief that "numbers don't lie." The danger is that one erroneous calculation might be accepted as proof of guilt beyond a reasonable doubt.<sup>23</sup> Of course, the defense might present its own expert whose opinions would be more favorable to the defendant, but this might not solve the underlying problem of potential prejudice which results from a juror's inability to recognize that he may be misled by an impressive show of numbers with little probative value.<sup>24</sup>

A "battle of experts" is risky in that it can result in overemphasis of evidence that is of limited collateral importance. Some courts have expressed concern that mathematically expressed probabilities might distract a jury from deciding the proper factual issues of the case.<sup>25</sup> For example, consider a hypothetical murder trial in which the prosecution offers evidence that a hair from the defendant's head was found on the victim's body. Even if it were undisputed that the hair was the defendant's, that fact could not properly be regarded as more than a single link in a chain of inferences needed to prove the defendant's guilt. A prosecution expert, however, might testify extensively as to the reliability of identification through hair analysis tests and conclude that there is only one chance in a thousand that the hair does not belong to the defendant. A jury relying on the assumed infallibility of science might confuse identification of the defendant as the owner of the hair with identification of the defendant as the perpetrator of the crime. The danger is even greater if defense counsel is forced to mount his own expert attack in an attempt to rebut the prosecu-

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22. See *Collins*, 68 Cal. 2d at 330-31, 438 P.2d at 40-41, 66 Cal. Rptr. at 504-05.

23. Cf. *Carlson*, 267 N.W.2d at 176 ("Testimony expressing opinions or conclusions in terms of statistical probabilities can make the uncertain seem all but proven . . ."), quoted in *United States v. Massey*, 594 F.2d 676, 681 (8th Cir. 1979).

24. See *Collins*, 68 Cal. 2d at 330-32, 438 P.2d at 40-41, 66 Cal. Rptr. at 504-05; *State v. Boyd*, 331 N.W.2d 480, 482 (Minn. 1983); *Carlson*, 267 N.W.2d at 176; Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 HARV. L. REV. 1329, 1355 (1971). For further discussion of the increased danger of prejudice peculiar to mathematically expressed probabilities, see *infra* text, section III.

25. See *Collins*, 68 Cal. 2d at 327, 438 P.2d at 38, 66 Cal. Rptr. at 502; *Boyd*, 331 N.W.2d at 482-83; Note, *supra* note 7, at 334-35.



tion's probability evidence. With so much effort devoted to contesting the defendant's connection to the hair, the jury might forget the logical necessity of finding a connection between the hair and the murderer.<sup>26</sup>

*B. The Admissibility of Mathematically Expressed Probabilities in Williams v. State*

Neither the Supreme Court of Georgia nor the Georgia Court of Appeals has produced a majority opinion analyzing the potential difficulties associated with the admissibility of mathematically expressed probabilities,<sup>27</sup> although the issue was raised on appeal in *Williams v. State*.<sup>28</sup> The majority opinion in *Williams*, however, approves summarily and uncritically the admission of expert probability testimony.

Expert testimony was used in the murder trial of Wayne Williams to demonstrate a physical link between Williams and the two victims with whose murders Williams was charged. Two experts, FBI special agent Deadman and State Crime Laboratory microanalyst Peterson, testified at length about various comparison tests they had performed on small fibers found on the bodies of the victims and fibers found in the home and other environments of Williams.<sup>29</sup> The experts explained in detail the fiber comparison tests and the distinguishing characteristics of fibers upon which they based their comparisons.<sup>30</sup> Each expert testified that, in his opinion, it was "virtually impossible" for there to have been no contact

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26. See *Collins*, 68 Cal. 2d at 330-32, 438 P.2d at 40-41, 66 Cal. Rptr. at 504-05. It is true that a jury might be distracted by nonmathematically expressed opinions regarding the hair's origin; the problem of jury distraction is not unique to opinions couched in mathematical terms. The danger of distraction increases, however, as the amount of detailed information increases. Thus, a jury haggling over numbers representing degrees of likelihood that the hair is defendant's will be more distracted than a jury not concerned about the significance of a precise quantification.

27. During the final four months of 1983, however, two nonmajority appellate opinions in Georgia discussed the use of mathematically expressed probabilities in criminal trials. These opinions were in *Graham v. State*, 168 Ga. App. 23, 308 S.E.2d 413 (1983) (Deen, J., concurring specially), and *Williams v. State*, 251 Ga. 749, 312 S.E.2d 40 (1983) (Smith, J., dissenting).

28. 251 Ga. 749, 312 S.E.2d 40 (1983).

29. *Id.* at 755-60, 312 S.E.2d at 52-55. Expert fiber testimony relating to 10 extrinsic offenses (alleged homicides with which Williams was not charged) was also admitted by the trial court. See *id.* at 755, 312 S.E.2d at 51. The Supreme Court of Georgia rejected Williams' contention that evidence of the extrinsic offenses should have been excluded. See *id.* at 785, 312 S.E.2d at 71.

30. See *id.* at 755-56, 312 S.E.2d at 52; Transcript, *supra* note 3, at 2026-2275.

between the victims and Williams or his environment.<sup>31</sup>

Each expert also testified as to certain mathematically expressed probabilities which were related to the fiber comparisons.<sup>32</sup> Deadman testified that once he determined that two fibers were similar (i.e., that they displayed no "significant" differences),<sup>33</sup> a further determination was necessary to evaluate the *significance* of the similarity.<sup>34</sup> Deadman explained that the significance of a fiber match depends in part on whether the fibers in question occur commonly or relatively rarely in the general environment.<sup>35</sup> Although the experts never attempted to *quantify* the significance of the fiber similarities they reported, the relative rarity of two kinds of fibers tested by the experts was illustrated by mathematical calculations in order to maximize the significance of the fiber matches.<sup>36</sup>

One type of uncommon fiber which the experts found similar to fibers recovered from victims' bodies came from the rayon floor-board carpet of a 1970 Chevrolet station wagon driven by Williams when the police first questioned him.<sup>37</sup> Both experts testified that they had information that only 620 out of over two million cars in the Atlanta area had that kind of carpet.<sup>38</sup>

The second type of fiber considered unique by the prosecution

31. See *Williams*, 251 Ga. at 821, 312 S.E.2d at 96 (Smith, J., dissenting). Note that an expert opinion that the occurrence of an event is "virtually impossible" is not technically a mathematically expressed probability. Nevertheless, if such an opinion is actually based on erroneous or misleading probabilities, the opinion itself might be considered unfairly prejudicial or incompetent. Justice Smith, dissenting in *Williams*, felt that all of Deadman's probability evidence was incompetent and that Deadman's ultimate conclusion ("virtually impossible") was therefore inadmissible. See *id.* at 826, 312 S.E.2d at 99 (Smith, J., dissenting).

32. For example, the experts testified that they received information (apparently supplied by General Motors) that only 620 out of over two million cars in the Atlanta area would have the same type of carpet as Williams' car. *Id.* at 824, 312 S.E.2d at 98 (Smith, J., dissenting).

33. Whether an observed difference between two fibers is "significant" is, of course, a matter of opinion.

34. See Transcript, *supra* note 3, at 2068.

35. *Id.* at 2068-69. Deadman illustrated this point by using as an example white cotton fibers which might be found in a t-shirt. Associating such a common fiber with both the victim and the suspect would be of very little significance.

36. See *Williams*, 251 Ga. at 821-24, 312 S.E.2d at 96-98 (Smith, J., dissenting); Transcript, *supra* note 3, at 2285-91. The prosecution, however, did attempt to quantify the significance of the fiber associations in closing argument. See Transcript, *supra* note 3, at 6881-83.

37. See *Williams*, 251 Ga. at 822, 312 S.E.2d at 97 (Smith, J., dissenting). Cf. *id.* at 756-72, 312 S.E.2d at 52-63 (listing various alleged fiber associations between Williams and each homicide victim).

38. See *id.* at 824, 312 S.E.2d at 98 (Smith, J., dissenting).

was identified as 181-b nylon, manufactured by the Wellman company.<sup>39</sup> Fibers similar to 181-b were recovered from the victims' bodies and taken from Williams' green bedroom carpet.<sup>40</sup> There was testimony that Williams' carpet was similar to "Luxaire" brand carpet, produced in limited quantity by West Point Pepperell from 181-b fiber during 1970-71.<sup>41</sup> In order to establish that Williams had been in contact with the victims, the prosecutor elicited from Deadman a series of mathematical calculations culminating in Deadman's opinion that the odds of finding carpet similar to that of Williams in an Atlanta area home chosen at random were one in 7,792.<sup>42</sup> Deadman admitted that his opinion was merely an estimate based in part on assumptions which were not verifiable.<sup>43</sup>

Deadman's calculation was an estimate of the probability that a random Atlanta area household would contain Luxaire carpet, a brand of carpet similar to that found in Williams' home. This probability could, in theory, be calculated accurately by dividing the total number of Atlanta area households into the number of such households which contain Luxaire carpet.<sup>44</sup> Deadman derived an estimate of the number of Atlanta area households containing Luxaire carpet from West Point Pepperell sales records.<sup>45</sup> The records used by Deadman reflected the *combined* sales of Luxaire carpet *and another brand*, Dreamer carpet, during 1971 and 1972. During 1971-72 the combined sales of both brands totaled about 16,397 square yards in a ten-state region including Georgia.<sup>46</sup>

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39. See *id.* at 757, 312 S.E.2d at 53; *id.* at 822-23, 312 S.E.2d at 97 (Smith, J., dissenting). Cf. *id.* at 756-72, 312 S.E.2d at 52-63 (listing various alleged fiber associations between Williams and each homicide victim).

40. See *id.* at 756-72, 312 S.E.2d at 52-63.

41. See *id.* at 757-58, 312 S.E.2d at 53; Transcript, *supra* note 3, at 2285-88.

42. See *Williams*, 251 Ga. at 824, 312 S.E.2d at 98 (Smith, J., dissenting); Transcript, *supra* note 3, at 2291.

43. See Transcript, *supra* note 3, at 2291.

44. If it is not clear why the number of households containing Luxaire divided by the total number of households equals the probability of randomly selecting a household containing Luxaire, consider the following explanation. In general, if  $x$  and  $y$  are numbers, and if a set which consists of only two types of items contains  $x$  items of one type and  $y$  items of a second type, then the probability that an item chosen at random from the set will be of the second type is  $y/(x+y)$ . Thus, out of a set of six red shoes and four black shoes, the probability that a randomly chosen shoe will be black is  $4/(4+6)$  or  $4/10$ . Out of a set of  $x$  households without Luxaire carpet and  $y$  households with Luxaire carpet, the probability that a randomly selected household will contain Luxaire carpet is  $y/(x+y)$ , which is the number of households containing Luxaire divided by the total number of households.

45. See Transcript, *supra* note 3, at 2285-91.

46. *Id.* at 2289.

Deadman treated this combined sales total as an adequate approximation of the amount of Luxaire carpet which might have ended up in the ten-state region.<sup>47</sup> Deadman estimated that twenty square yards was a reasonable amount of carpet for an average room and concluded that carpeting for approximately 820 rooms had been sold for residential use in the ten-state region.<sup>48</sup> Deadman assumed that ten percent of the carpet sold in the ten-state region would be sold in Georgia.<sup>49</sup> Therefore, he concluded, one might expect to find eighty-two rooms carpeted with Luxaire in Georgia.<sup>50</sup> In order to narrow the focus from Georgia to Atlanta, Deadman assumed that all eighty-two rooms of Luxaire would be in Atlanta.<sup>51</sup> This assumption, considered by the prosecution to be "very, very beneficial to the defense,"<sup>52</sup> would make Luxaire seem more common in the Atlanta area. Deadman made another assumption which the prosecution considered favorable to the defendant; he assumed that each house containing Luxaire had only one room carpeted with it, thus maximizing the total number of households expected to contain Luxaire.<sup>53</sup> Therefore, according to Deadman, eighty-two households in the Atlanta area might be expected to contain Luxaire carpet.<sup>54</sup> Finally, using a figure for the number of Atlanta area housing units obtained from the Atlanta Regional Commission and his calculations based on Luxaire carpet sales records, Deadman estimated that the odds of a randomly selected household containing carpet similar to that of Williams were 82/638,992 or one in 7,792.<sup>55</sup>

It is clear that Deadman's testimony consisted of mathematically expressed probabilities and that it was intended to forge a link in a

47. Deadman's use of combined sales figures for Luxaire and Dreamer carpets in 1971-72 was, at best, a very rough approximation of the actual amount of Luxaire carpet in the ten-state region. Moreover, possible sales after 1972 were not considered, and the figures did not account for carpet of less than first quality which was disposed of in different ways. *Cf. id.* at 2007-09 (testimony relating to separate sales records for first-quality merchandise).

48. Transcript. *supra* note 3, at 2290.

49. *Id.*

50. *Id.* Deadman's assumption that Georgia received 10% of the carpet sold in the ten-state region had a large impact on the calculation of the carpet's "rarity" in Georgia. Suppose, for example, that 90%, rather than 10%, was sold in Georgia. This would result in an estimated 738 rooms in Georgia with Luxaire carpet, rather than only 82 rooms.

51. *Id.* at 2291.

52. *Id.* at 6881.

53. *Id.* at 2291, 6881.

54. *Id.* at 2290-91.

55. *See id.* at 2291.

chain of inferences which would identify Williams as the guilty party. Although Deadman drew no further inferences suggesting a correlation between the calculations and Williams' guilt, the calculations themselves would be scrutinized closely by some courts.

The probability testimony suffered from three defects which, in other jurisdictions, might have justified a finding that the trial court erred in admitting the testimony. First, Deadman's opinion was based in part on purely speculative estimates.<sup>56</sup> There was no support for his assumption that only ten percent of the Luxaire and Dreamer carpets was sold in Georgia or for his assumptions regarding the distribution of those carpets within the state and within the Atlanta area. Furthermore, the logical relevance of Deadman's entire series of calculations hinged upon a crucial but unacknowledged assumption—that Williams' carpet *actually was Luxaire*.<sup>57</sup> Although there was testimony that Williams' carpet was similar to Luxaire, that testimony was not based on microscopic comparisons of individual fibers.<sup>58</sup> Justice Smith's dissent in *Williams* refers to the identification of Williams' carpet as Luxaire as a "wholly speculative assumption."<sup>59</sup> As viewed by the Kansas Supreme Court, "Expert testimony of mathematical probabilities . . . is generally inadmissible when based on estimations rather than on established facts."<sup>60</sup> Moreover, the unreliability of the expert's underlying assumptions is not cured merely by his assigning speculative estimates which seem "fair" to the defendant.<sup>61</sup>

Second, Deadman's testimony, like the probabilities used in *People v. Collins*,<sup>62</sup> "lacked an adequate foundation . . . in statistical theory."<sup>63</sup> The sales figures used in Deadman's calculations re-

56. The supreme courts of Arkansas and New Mexico have held probability evidence in criminal trials inadmissible when based on speculative estimates. See *Miller v. State*, 240 Ark. 340, 344, 399 S.W.2d 268, 270 (1966); *State v. Sneed*, 76 N.M. 349, 354, 414 P.2d 858, 862 (Sup. Ct. 1966).

57. See *Williams*, 251 Ga. at 823-24, 824 n.7, 312 S.E.2d at 97-98, 98 n.7 (Smith, J., dissenting).

58. See *id.* at 757-58, 312 S.E.2d at 53. The prosecution presented testimony based on microscopic comparison of Williams' carpet to 181-b fiber, but not to individual fibers of Luxaire carpet. See *id.* at 757, 312 S.E.2d at 53.

59. *Id.* at 823-24, 312 S.E.2d at 98 (Smith, J., dissenting).

60. *State v. Washington*, 229 Kan. 47, 58-59, 622 P.2d 986, 994 (1981).

61. "Guesses, even by experts, are still guesses and should not be allowed due to the prejudicial effect they may have on defendants." Braun, *Quantitative Analysis and the Law: Probability Theory as a Tool of Evidence in Criminal Trials*, 1982 UTAH L. REV. 41, 62.

62. 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968).

63. *Id.* at 327, 438 P.2d at 38, 66 Cal. Rptr. at 502. In *Collins*, a procedure properly applicable only to independent variables was erroneously applied to variables whose

flected only sales of first-quality carpet.<sup>64</sup> Additional quantities of Luxaire carpet were sold as "imperfect" merchandise, some of which might have been distributed in Georgia or even installed in Atlanta residences.<sup>65</sup> Deadman's failure to consider these additional quantities of Luxaire carpet indicates unreliability in his method of calculation. Furthermore, the expert's testimony was supposedly relevant to proving the rarity of a certain type of fiber (181-b nylon) in the general environment.<sup>66</sup> Deadman's method of calculation, however, did not account for all the Luxaire carpet produced nor for all the 181-b fiber distributed in Georgia.<sup>67</sup> Moreover, since Deadman restricted the scope of his calculations to households, his method failed to take into account the non-residential portions of the Atlanta environment. Therefore, Deadman erroneously relied on statistics which could not be used to form a valid opinion relevant to the rarity of 181-b fiber in the general environment of Atlanta.<sup>68</sup>

Third, Deadman's testimony might be regarded by some courts as a use of mathematically expressed probabilities which could confuse a jury by focusing the jury's attention on a collateral issue.<sup>69</sup> Once a juror is convinced that Luxaire is indeed very rare, will the juror remember that there is a chance that Williams' car-

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independence had not been demonstrated. *See supra* note 15. In *Williams*, Deadman's calculations might have been considered invalid because the statistical data relied upon were speculative and selected so as to exclude significant factors necessary to a relevant conclusion. *See supra* text accompanying notes 56-59.

64. *See* Brief on Behalf of the Appellant at 121, *Williams* [hereinafter cited as Appellant's Brief]; *cf.* Transcript, *supra* note 3, at 2007-09 (testimony relating to separate sales records for first-quality merchandise).

65. *See* Appellant's Brief, *supra* note 64, at 121.

66. The significance of a fiber association between the victim and the suspect depends in part on whether the fibers are of a type which occurs only rarely in the general environment. *See* Transcript, *supra* note 3, at 2068-69 (Deadman's testimony); *supra* text accompanying notes 34-35; *supra* note 35.

67. West Point Pepperell, the maker of Luxaire carpet, was not the only Georgia purchaser of 181-b nylon. According to sales figures in State's Exhibit 622, as much as 94% of the 181-b fiber sold in Georgia might have been unaccounted for in Deadman's calculations. Appellant's Brief, *supra* note 64, at 120; *see* Transcript, *supra* note 3, at 7492-93.

68. Deadman's own assessment of the validity of his probability testimony was published after the trial and appeal of *Williams*. *See* Deadman, *Fiber Evidence and the Wayne Williams Trial (Conclusion)*, 53 FBI LAW ENFORCEMENT BULL., May 1984, at 10. In his opinion, "The probability figures illustrate clearly that the Williams' carpet is, in fact, very uncommon." *Id.* at 13.

69. Prejudicial confusion of the jury has been a primary concern of the courts which have addressed the admissibility of probability evidence. *See supra* notes 17-26 and accompanying text.

pet was not Luxaire? Once a juror is told that the odds of finding Luxaire carpet in a random Atlanta household are one in 7,792, will the juror remember that those odds were derived from other numbers indicating that eighty-one Atlanta homes other than the defendant's contain the "rare" carpet? Finally, once a juror is convinced that Williams' carpet was the very rare Luxaire, will the juror remember that proof of a physical link between a homicide victim and a defendant is not equivalent to proof that the defendant is a murderer?

The Supreme Court of Georgia, in its majority opinion affirming Williams' conviction, mentioned none of the above infirmities of Deadman's testimony. In a single sentence, Justice Bell disposed of Williams' claim that Deadman's probability testimony was erroneously admitted: "[E]xperts are permitted to give their opinions, based upon their knowledge, including mathematical computations."<sup>70</sup> The only case cited in support of this proposition was *Stewart v. State*.<sup>71</sup> In *Stewart*, the Supreme Court of Georgia found that the Director of the Chattooga County Department of Family and Children Services had been qualified as an expert witness and was competent to testify as to the amount of public assistance funds which the defendant had been entitled to receive.<sup>72</sup> The expert testimony in *Stewart* had nothing to do with potentially confusing and complex statistical computations. Therefore, the precedential value of *Stewart* seems quite limited in a situation involving expert probability testimony.

Furthermore, in *Stewart*, the court found the Director's expert testimony to be defective, although not because it relied on her mathematical computations. The Director's computations were based on departmental regulations which were not in evidence nor examinable by the jury.<sup>73</sup> The court stated: "Where an expert testifies to a conclusion based on information furnished by others . . . , then all the information utilized by that expert in forming an opinion should be presented to the jury to enable the jury to evaluate the expert's testimony."<sup>74</sup> The reasoning of *Stewart* would therefore support the exclusion of Deadman's testimony based on information furnished by others and not in evidence.<sup>75</sup>

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70. *Williams*, 251 Ga. at 786, 312 S.E.2d at 72.

71. 246 Ga. 70, 268 S.E.2d 906 (1980).

72. *See id.* at 75, 268 S.E.2d at 911.

73. *Id.* at 75-76, 268 S.E.2d at 912.

74. *Id.* at 76, 268 S.E.2d at 912.

75. *See Williams*, 251 Ga. at 825, 312 S.E.2d at 98 (Smith, J., dissenting).

The *Williams* majority apparently considered Deadman's mathematical computations to be based on his knowledge and therefore admissible as an expert opinion.<sup>76</sup> Although Deadman's method of deriving the probability was explained, his use of speculative estimates and secondhand information undercuts the reliability of his method and the trustworthiness of his results. In light of Deadman's reliance on unverified assumptions, it seems inappropriate to justify the admission of his testimony as being based on his knowledge.

Justice Bell's opinion did not address the potential of probability evidence to mislead, confuse or distract the jury. The jury's perception of the expert testimony is particularly important in *Williams* because of the prosecution's emphasis on mathematically expressed probabilities during its closing argument.<sup>77</sup>

Consideration by the court of the various problems raised by the use of mathematically expressed probabilities would not necessarily have resulted in a reversal of Williams' conviction. Other courts have held the improper admission of such evidence to be harmless error.<sup>78</sup> The Georgia court could have found that admitting Deadman's probability testimony was harmless error because the testimony was merely corroborative of other nonmathematically expressed opinions.<sup>79</sup> Instead, the court approved the admission of the testimony with almost no comment. In the absence of standards specifically governing the admissibility of probability evidence, *Williams* might be relied upon as permitting the use of mathematically expressed probabilities even when the probabilities are based on speculative estimates and are only tenuously related to an expert's field of competence.

## II. THE PROSECUTION'S USE OF MATHEMATICALLY EXPRESSED PROBABILITIES IN CLOSING ARGUMENT

Whether or not probability evidence has been introduced at trial, a prosecutor may try to persuade the jury by using mathematically expressed probabilities in closing argument. The focus of this section is such prosecutorial argument rather than the admis-

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76. See *supra* text accompanying note 70.

77. See *infra* text accompanying notes 110-21.

78. See, e.g., *Commonwealth v. Drayton*, 386 Mass. 39, 50-51, 434 N.E.2d 997, 1006 (1982); *State v. Carlson*, 267 N.W.2d 170, 176 (Minn. 1978).

79. Both experts testified that it was "virtually impossible" that the victims had not been in contact with Williams or his environment. *Williams*, 251 Ga. at 821, 312 S.E.2d at 96 (Smith, J., dissenting). Cf. *supra* note 31.



sibility of expert probability testimony. This section considers the traditional bounds of argument, the special considerations which may pertain to the argument of mathematically expressed probabilities, and the prosecution's argument in the Georgia murder trial of Wayne Williams.

A. *The Scope of Permissible Argument and Inference by a Prosecutor*

Generally, an attorney is allowed considerable latitude in his argument to the jury.<sup>80</sup> The attorney may draw any inference from the evidence admitted at trial, even unreasonable, illogical or absurd inferences.<sup>81</sup> The scope of permissible argument is left to the sound discretion of the trial court.<sup>82</sup> There are, however, certain restrictions on the latitude enjoyed by the prosecution in its closing argument which are germane to this discussion: the prosecution may not make statements which would impair the defendant's constitutional right to a fair trial, and the prosecution may not misstate the testimony or introduce facts which are not in evidence.<sup>83</sup>

Courts outside of Georgia have considered various factors in deciding whether a prosecutor's argument of mathematically expressed probabilities has denied the defendant a fair trial. Generally, the reasons for excluding certain calculations of probability from evidence also pertain to limiting the argument of such calculations. For example, the argument might result in unfairly prejudicial confusion or misleading of the jury.<sup>84</sup>

It has been suggested that a jury's overreliance on persuasively argued probabilities might displace the proper jury function of determining whether each element of a criminal offense has been proved beyond a reasonable doubt.<sup>85</sup> Courts have rejected the no-

80. See, e.g., *Alexander v. State*, 150 Ga. App. 41, 43-44, 256 S.E.2d 649, 651-52 (1979).

81. *Montos v. State*, 212 Ga. 764, 768, 95 S.E.2d 792, 796 (1956) (citing *Owens v. State*, 120 Ga. 209, 47 S.E. 545 (1904)).

82. See *Wisdom v. State*, 234 Ga. 650, 655, 217 S.E.2d 244, 249 (1975).

83. See *Wheeler v. State*, 220 Ga. 535, 537, 140 S.E.2d 258, 261 (1965); *Sanford v. State*, 203 Ga. 451, 453, 47 S.E.2d 268, 270 (1948) (quoting *Ogletree v. State*, 115 Ga. 835, 835-36, 42 S.E. 255, 255 (1902)).

84. Cf. *People v. Collins*, 68 Cal. 2d 319, 330, 438 P.2d 33, 40, 66 Cal. Rptr. 497, 504 (1968) ("Confronted with an equation which purports to yield a numerical index of probable guilt, few juries could resist the temptation to accord disproportionate weight to that index . . .").

85. See *id.* at 331-32, 438 P.2d at 41, 66 Cal. Rptr. at 505; *State v. Carlson*, 267 N.W.2d 170, 176 (Minn. 1978); Note, *supra* note 7, at 334-35.

tion that a legal burden of proof can or should be evaluated with mathematical precision.<sup>86</sup> A "preponderance of the evidence" in a civil case cannot be equated with a statistical likelihood greater than fifty percent, even though the verbal formulation of the standard is "more likely than not."<sup>87</sup> Similarly, proof "beyond a reasonable doubt" cannot be equated with a probability of 99.9% or with any precise mathematical expression. A prosecutor's argument to the jury that mathematically expressed probabilities alone should satisfy the government's burden of proof may therefore constitute reversible error.<sup>88</sup>

Some courts have limited the prosecution's scope of permissible inference where statistically invalid calculations have been used. In *People v. Collins*,<sup>89</sup> the Supreme Court of California reversed a robbery conviction on various grounds, including the prosecutor's use of the testimony of a mathematics professor in such a manner as to distract and confuse the jury and the defense.<sup>90</sup> The expert witness in *Collins* was qualified to testify regarding mathematical calculations, but the prosecution's unfounded assumptions and misuse of statistical principles resulted in reversal.

*United States v. Massey*<sup>91</sup> indicates other pitfalls for the unwary or unscrupulous prosecutor. In *Massey*, the Eighth Circuit reversed a robbery conviction partly because the prosecutor had misrepresented the testimony as to probabilities and because he had argued that the statistical evidence "would be proof beyond a reasonable doubt because it is so convincing."<sup>92</sup> The prosecutor also made the mistake of confusing the establishment of a physical link between the defendant and the crime scene with the establishment of proof of guilt.<sup>93</sup>

In *United States ex rel. DiGiacomo v. Franzen*,<sup>94</sup> the Seventh Circuit distinguished *Massey* on the grounds that the mathematical evidence used in DiGiacomo's trial was corroborative of an eyewitness identification, that the prosecutor never argued that the mathematically expressed probabilities should be conclusive proof,

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86. See *United States v. Massey*, 594 F.2d 676, 681 (8th Cir. 1979); *Carlson*, 267 N.W.2d at 176.

87. See *Smith v. Rapid Transit, Inc.*, 317 Mass. 469, 470, 58 N.E.2d 754, 755 (1945).

88. See *Massey*, 594 F.2d at 681.

89. 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968).

90. See *id.* at 327-32, 438 P.2d at 38-41, 66 Cal. Rptr. at 502-05.

91. 594 F.2d 676 (8th Cir. 1979).

92. *Id.* at 680-81 (quoted material emphasized in original).

93. See *id.* at 681.

94. 680 F.2d 515 (7th Cir. 1982).

and that the prosecutor did not confuse the issues of physical association and guilt.<sup>95</sup> In *DiGiacomo*, unlike *Massey*, the prosecutor's argument referred to the probability evidence only as additional circumstantial evidence to be considered along with all the other evidence.<sup>96</sup> The court affirmed the denial of a petition for a writ of habeas corpus despite the fact that the probability evidence apparently had confused the jury to some extent.<sup>97</sup> Nevertheless, the court acknowledged that "the better practice may be . . . to instruct the jury on the limitations of mathematical probability whenever such evidence is admitted . . . ."<sup>98</sup>

*Collins*, *Massey*, and *DiGiacomo* illustrate that the manner in which the prosecution uses mathematically expressed probabilities *after* they are in evidence may determine whether a conviction is upheld on appeal. However, a recent example of the traditionally broad latitude enjoyed in closing argument is found in *Roach v. State*.<sup>99</sup> In *Roach*, an Indiana appellate court upheld a conviction in spite of a rambling argument at trial in which the prosecutor suggested completely unfounded probabilities to the jury, culminating in the prosecutor's guess that the odds were one in ten million that someone other than the defendant could be the guilty party.<sup>100</sup> The Indiana court distinguished *Collins* on the ground that the jurors in *Collins* were *required* to accept unproven assumptions as facts, whereas in *Roach* "the prosecutor merely supplied a method of analyzing the evidence in the record, leaving the jurors free to assign any statistical probability to the various

95. *Id.* at 518-19.

96. *See id.* at 518 n.4.

97. *See id.* at 516, 518.

98. *Id.* at 519.

99. 451 N.E.2d 388 (Ind. Ct. App. 1983).

100. Although the reported text of the *Roach* prosecutor's argument is most illuminating, a short excerpt will serve to demonstrate the prosecutor's latitude in closing argument:

Next what's the possibility that this individual with glass in his shoe had the same footprints and ultimately ended up in the Defendant's car? . . . One in a thousand? One in a hundred? . . . One in ten? I don't know. Put any value that you feel. Taking these and using the fair figures, one in a thousand here on the glass, what's the possibility that all these things happened, all these circumstances happened all at the same time? One in a thousand here. One in a hundred here. . . . I don't know. Maybe it's a little bit more. Maybe it's a little bit less. But using these amounts, there's three, four, five, six, seven zeroes. One in ten million, chances of all these things happening.

*Id.* at 392.

facts.”<sup>101</sup> However, the Indiana court’s distinction between the arguments in *Roach* and *Collins* is illusory; the *Collins* prosecutor in fact *did* invite the jury to assign its own probabilities, but the conviction was nevertheless reversed.<sup>102</sup>

The viewpoint illustrated by *Roach* is that a prosecutor may use mathematically expressed probabilities, even wholly speculative ones, as a means of presenting inferences to the jury. Even the *Roach* court, however, indicated its adherence to the rule that a prosecutor is not allowed to argue facts not in evidence,<sup>103</sup> and this rule is also followed in Georgia.<sup>104</sup> The following section of this Note will show that, in the absence of particularized standards, a prosecutor’s closing argument might distort probability testimony so subtly that a substantial misrepresentation of the testimony might go undetected.

*B. Argument of Mathematically Expressed Probabilities in Williams v. State*

The prosecution in *Williams*, relying on the expert fiber and probability evidence, argued:

[I]n order for there to be another killer in Atlanta with the same environment as Wayne Williams, he’d have to have the same kind of carpet, same kind of dog, the same kind of bedspread, the same kind of blanket, the same kind of toilet cover, the same kind of carpet squares, the same kind of . . . bedspread hanging up in his porch, the same white polyester, the same jacket, the same gloves, the same blue rayon, and he’d have to have the same hair as Wayne Williams.<sup>105</sup>

The prosecution’s witnesses never attributed such a specific array of characteristics to a hypothetical “other killer.”<sup>106</sup> Nevertheless,

101. *Id.*

102. See *Collins*, 68 Cal. 2d at 325 n.10, 438 P.2d at 37 n.10, 66 Cal. Rptr. at 501 n.10.

103. *Roach*, 451 N.E.2d at 392.

104. See *Wheeler*, 220 Ga. at 537, 140 S.E.2d at 261; *Montos*, 212 Ga. at 768, 95 S.E.2d at 796; *Sanford*, 203 Ga. at 453, 47 S.E.2d at 270; *Patterson v. State*, 124 Ga. 408, 409, 52 S.E. 534, 535 (1905).

105. Transcript, *supra* note 3, at 6882-83.

106. As pointed out in *Williams*’ appellate brief, the prosecutor’s argument, although supposedly based on Deadman’s probability testimony, “served to confuse the jury as to [the] meaning [of the probability testimony] in relation to the other circumstantial evidence. . . . [The probability testimony] had nothing to do with the dog, the bedspread . . . , the white polyester, the jacket, the glove, the blue rayon, or Wayne Williams’ hair.” Appellant’s Brief, *supra* note 64, at 115-16.

to the extent that the prosecutor might have drawn illogical inferences from the expert testimony, he would have remained within the traditional scope of permissible argument.<sup>107</sup> In rejecting Williams' claim that the argument had been improper, the *Williams* majority stated: "Counsel are given wide latitude in closing argument, and are not prohibited from suggesting to the jury inferences which might be drawn from the evidence."<sup>108</sup>

The prosecutor did more, however, than draw nonmathematical inferences from the expert testimony. He also presented to the jury mathematically expressed probabilities relating to the fiber evidence.<sup>109</sup> These probabilities, purportedly based on an expert's analysis, were actually founded on a *misstatement* of Deadman's testimony by the prosecutor. The misstatement substantially altered the essential meaning of the mathematically expressed probabilities in evidence. The phrasing of the prosecutor's misquotation, however, was similar to Deadman's actual testimony. Thus, given that the significance of mathematically expressed probabilities is easily misunderstood, an average juror or attorney might never have noticed the prosecutor's misstatement of the evidence.

The prosecutor emphasized that the assumptions made by the expert, Deadman, had been more than fair to the defendant, and reminded the jury of Deadman's opinion that "there would only be one chance in eight thousand that there would be another house in Atlanta that would have the same kind of carpeting as the Williams home."<sup>110</sup> The prosecutor's statement to the jury actually bettered the odds in Deadman's testimony by an extraordinary amount and to the benefit of the prosecution.

Deadman actually said that the odds were one in 7,792 that an Atlanta household *chosen at random* would contain carpet similar to Williams' carpet.<sup>111</sup> The transformation of the number 7,792 in

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Attorney Lynn Whatley's cooperation in making certain research materials available is gratefully acknowledged.

107. Cf. *Wisdom*, 234 Ga. at 655, 217 S.E.2d at 249 (permitting prosecutorial inferences "however illogical they may seem to the opposite party"); *Wheeler*, 220 Ga. at 537, 140 S.E.2d at 261 (citing as grounds for mistrial an argument "which introduces facts not in evidence and is calculated to prejudice the defendant, not flights of oratory, figurative speech or false logic").

108. *Williams*, 251 Ga. at 786, 312 S.E.2d at 73 (citing *Wisdom v. State*, 234 Ga. 650, 655, 217 S.E.2d 244, 249 (1975)).

109. See *Williams*, 251 Ga. at 786, 824, 312 S.E.2d at 72-73, 98; Transcript, *supra* note 3, at 6881-82.

110. Transcript, *supra* note 3, at 6881.

111. See *id.* at 2291; *Williams*, 251 Ga. at 824, 312 S.E.2d at 98 (Smith, J., dissenting).

Deadman's testimony to 8,000 in the closing argument is *not* the important difference. Even if the prosecutor had said "one chance in 7,792" rather than "one chance in 8,000," he still would have been misquoting Deadman's analysis in such a way as to greatly enhance the significance of Deadman's testimony.<sup>112</sup>

Deadman's opinion as to the probability of a random household containing Luxaire carpet was based on his own estimate that there were eighty-two such households in the Atlanta area. Even if Williams' home were one of those eighty-two households, Deadman's own estimations and assumptions indicate that there would be eighty-one other Atlanta households containing Luxaire. Therefore, if Williams' home contained Luxaire carpet, and if Deadman's own estimations and assumptions were accepted as true, the probability that at least one other household in Atlanta would have the same type of carpet as Williams' home would be *one hundred percent*,<sup>113</sup> not one in 8,000 as stated by the prosecutor.<sup>114</sup> Given the complexity of the subject matter, however, the jurors and defense counsel might well have relied on the prosecutor's version of Deadman's analysis as an accurate paraphrase.

The prosecutor then reminded the jury of the testimony that only about 600 cars out of two and a half million in the Atlanta

112 In order to understand fully the explanation in the text, the reader may wish to review Deadman's analysis, *supra* text accompanying notes 42-55, and the prosecutor's version of Deadman's testimony, *supra* text accompanying note 110.

113. In other words, if Deadman's estimate that there are 82 houses with Luxaire carpet were accepted as fact, it would be *certain* that at least one such house exists other than Williams' house.

If this is not clear, consider the following example. Imagine you have seven nickels and three pennies, making a total of ten coins in all. If you select one coin at random, the odds of selecting a penny are three out of ten or 3/10. Now take one penny away from the set of ten coins. What is the probability now that at least one of the remaining nine coins is a penny? 100%. It is certain that there is at least one penny other than the one you took away.

For a closer analogy to the odds calculated in *Williams*, try a similar exercise with 638,910 nickels and 82 pennies. The probability of randomly selecting a penny from this set of coins is 82/638,992 or about 1/7,792. Take away one penny. The probability that there is at least one penny left in the set of coins is 100%. It is certain that 81 of the 82 pennies you started with are still in the set.

114. Consider the difference in impact on the jury between probabilities of 100% and 1/8,000 that another Atlanta household would contain Luxaire carpet. Given Deadman's actual testimony that 82 Atlanta households might be expected to contain Luxaire carpet, a juror could be confident that Williams' home is merely one of many homes which might have the carpet. On the other hand, if there were, as the prosecutor said, a 1/8,000 chance of finding *any other house* with a carpet like that of Williams, a juror could easily be convinced that such another house does not exist; after all, the odds would be strongly against its existence.

area had carpet similar to that in the station wagon driven by Williams.<sup>115</sup> The prosecutor apparently figured the odds of choosing such a car at random to be about one in 5,000.<sup>116</sup> He multiplied 5,000 by 8,000 "in order to calculate the chances [sic] 'that there is another house in Atlanta that has the same kind of carpet as the Williams house and that the people who live in that house have the same type station wagon as the Williamses do . . .,' arriving at a probability of one in forty million."<sup>117</sup> The prosecutor next adjusted one of Deadman's "beneficial" assumptions, stating that a "more realistic view" would be that a householder using Luxaire carpet would probably carpet at least four rooms rather than only one.<sup>118</sup> Assuming that four rooms per household would be carpeted alike, the prosecutor concluded that the likelihood of the existence of an Atlanta household with the same kind of carpet and station wagon as Williams' was one in 150 million.<sup>119</sup>

The prosecutor's emphasis on mathematically expressed probabilities would have been subjected to close scrutiny in the courts that decided *People v. Collins*<sup>120</sup> and *United States v. Massey*.<sup>121</sup> The combination of unfounded assumptions in Deadman's testimony and in the closing argument, the prosecution's reliance on a distorted version of the expert's statement, and the potential prejudice and misleading effect on the jury might well have resulted in reversal. The majority opinion in *Williams*, however, did not discuss the possibility of limiting the use of mathematically expressed probabilities in closing argument. On the contrary, the opinion stated merely that inferences suggested to the jury "may include those based upon mathematical probabilities."<sup>122</sup>

Those portions of the argument which were nonmathematical or which were presented to the jury as the product of the prosecutor's own reasoning properly could have been considered inferences drawn from the evidence and thus within the traditional scope of

115. Transcript, *supra* note 3, at 6882.

116. *See id.* The prosecutor did not explain how the figure was derived, nor did he clearly identify its meaning except in relation to further questionable calculations.

117. *Williams*, 251 Ga. at 824, 312 S.E.2d at 98 (Smith, J., dissenting) (quoting, with ellipsis, Transcript, *supra* note 3, at 6882).

118. Transcript, *supra* note 3, at 6882; *see Williams*, 251 Ga. at 824, 312 S.E.2d at 98 (Smith, J., dissenting).

119. *See* Transcript, *supra* note 3, at 6882; *Williams*, 251 Ga. at 824, 312 S.E.2d at 98 (Smith, J., dissenting).

120. 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968).

121. 594 F.2d 676 (8th Cir. 1979).

122. *Williams*, 251 Ga. at 786, 312 S.E.2d at 73.

closing argument. The basis of the prosecutor's mathematical calculations, however, which was presented to the jury as a recapitulation of expert testimony, was in fact a misstatement of that testimony which recast its meaning and significance.

It is conceivable that the prosecutor's misquotation could have been challenged successfully as a prejudicial misstatement of the testimony or introduction of facts not in the record. This specific issue, however, was raised neither at trial nor on appeal,<sup>123</sup> although the argument of probabilities generally and other specific statements by the prosecution were challenged.<sup>124</sup> One possible explanation for this is that the misstatement was not recognized as such.<sup>125</sup> An inherent risk of permitting argument of mathematically expressed probabilities not subject to special standards is that a prejudicial misstatement of probability testimony might go unnoticed, uncorrected, and unchallenged.

### III. CONCLUSION

Expert opinions of mathematically expressed probabilities are inadmissible in some jurisdictions when there is inadequate factual foundation upon which to base a relevant opinion, when the methodology used in deriving the probability is unsound, or when the risk of distracting, misleading, or confusing the jury outweighs the probative value of the probability evidence. Moreover, the prosecution's use of mathematically expressed probabilities in argument may result in a finding of error if the argument misleads the jury or hinders its proper functioning. Usually, however, reversal of conviction has been based on the concurrence of more than one of these misuses of probabilities during trial.

For three reasons, mathematically expressed probabilities are

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123. Although the prosecutor's closing argument was quoted extensively in Williams' appellate brief, the misstatement of Deadman's testimony was not specifically challenged. Appellant's Brief, *supra* note 64, at 113, states that the prosecutor "'summarized' the fiber evidence and statistics, and added some magic math of his own for the jury." This statement, however, apparently refers only to the prosecutor's own calculations, not to the crucial misquotation on which the prosecutor's analysis was based.

124. Williams' challenge to specific prosecutorial statements was contained in Enumeration of Error No. 22, Appellant's Brief, *supra* note 64, at 207-16, concerning such statements as the prosecution's comparison of Williams to Attila the Hun and Adolf Hitler. *Id.* at 211. The Williams court did not address the merits of this challenge because no objection had been made at trial. *Williams*, 251 Ga. at 801-02, 312 S.E.2d at 82-83.

125. In fact, Williams' own appellate brief misquotes Deadman's testimony just as the prosecutor did in closing argument. Appellant's Brief, *supra* note 64, at 120.



more likely to mislead or confuse a jury than are other kinds of expert testimony. First, the assignment of a numerical quantity to the expert's assessment of probability gives the impression of scientific accuracy.<sup>126</sup> It is difficult to remember that an opinion expressed in mathematical terms is still merely an opinion. Thus, a jury might attach undue weight to the expert's opinion.

Second, it is the jury's function, not the expert's, to determine whether the events which are crucial to the government's case actually took place. This function necessarily involves the assessment of probabilities, although generally by a nonmathematical process. Therefore, expert testimony defining the probability of a significant event's occurrence could easily invade the province of the jury. The jury should not be encouraged to rely on experts' findings of probability which might not be accurate. While trustworthy probability evidence can help the jury make a more accurate determination of the facts, it is reasonable to require additional safeguards to insure that mathematically expressed probabilities considered by the jury are, in fact, reliable.

Third, there might be misunderstanding of the significance of mathematically expressed probabilities which could not be rectified even by competent testimony and cross-examination. It is relatively easy to understand an expert's opinion that a particular event happened or did not happen. It is much more difficult to comprehend the significance of an "eighty percent chance" that the event happened or might happen. Although the concept of an "eighty percent chance" might appear simple, the calculation of the odds might be erroneous or biased in a way that a juror, judge, or attorney would not understand.<sup>127</sup>

In late 1983, Judge Deen of the Georgia Court of Appeals and Justice Smith of the Supreme Court of Georgia filed opinions indi-

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126. Cf. *People v. Collins*, 68 Cal. 2d at 330, 438 P.2d at 40, 66 Cal. Rptr. at 504 (noting the likelihood that a jury would "accord disproportionate weight to [a numerical] index").

127. As an example of another biased (and invalid) calculation of odds connected with the *Williams* case, consider the following summary of an argument advanced on Williams' behalf in his Brief in Support of Motion for Rehearing. If 82 rooms in Atlanta contain the incriminating fiber, then 81 of those rooms are occupied by innocent people. "Therefore, there is 81/82, or 98.7%, chance that Wayne Williams' environment is that of an innocent man." Brief in Support of Motion for Rehearing at 5-6, *Williams*. If one of 620 similar cars is owned by a guilty person, then "619 out of 620 similar cars are those of innocent individuals. Therefore, there is a 619/620 or 99.838% chance that Appellant's car is that of an innocent individual. Multiplying the two statistical probabilities involved (81/82 X 619/620) therefore results in a 98.6% probability that Appellant is an innocent man . . . ." *Id.* at 6.

cating their willingness to scrutinize the use of mathematically expressed probabilities more closely in the future. In *Graham v. State*,<sup>128</sup> Judge Deen cited two leading probability cases, *People v. Collins*<sup>129</sup> and *State v. Sneed*,<sup>130</sup> and admonished the court to "use caution, care and concern when extrapolating possibility results in criminal cases based on mathematical and statistical probability."<sup>131</sup>

Justice Smith, dissenting in *Williams*, objected initially to the "fiber evidence" as failing to satisfy the required test for admission of scientific evidence.<sup>132</sup> Other portions of his opinion, however, indicate that Justice Smith was not so much concerned with scientific observations and test results as with the "expert testimony concerning the alleged uniqueness of two types of carpet fibers."<sup>133</sup> In Justice Smith's view, although "the proof of the recovery and comparison of fibers" was properly admitted,<sup>134</sup> the state had failed "to lay a foundation sufficient to establish that the methodologies its experts used to draw their inferences of significance [were] scientifically valid."<sup>135</sup> Justice Smith's opinion is suggestive of the viewpoint that Georgia should join the jurisdictions which have excluded mathematically expressed probabilities when the underlying methodology has not been proven reliable.

The majority opinion in *Williams* might be interpreted as permitting expert testimony and argument of mathematically expressed probabilities without regard to the reliability of the probabilities and without regard to the unfair prejudice which could result from the use of misleading or erroneous probabilities in criminal trials. The possibility that such evidence could hinder the proper functioning of the jury and be unfairly prejudicial to the defendant should be acknowledged in the future.

128. 168 Ga. App. 23, 308 S.E.2d 413 (1983).

129. 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968).

130. 76 N.M. 349, 414 P.2d 858 (Sup. Ct. 1966).

131. *Graham v. State*, 168 Ga. App. at 26, 308 S.E.2d at 416 (Deen, J., concurring specially).

132. *Williams*, 251 Ga. at 821-22, 312 S.E.2d at 96 (Smith, J., dissenting).

133. *Id.* at 822, 312 S.E.2d at 97 (Smith, J., dissenting).

134. *Id.* at 826, 312 S.E.2d at 99 (Smith, J., dissenting). Justice Smith also considered as properly admitted the experts' testimony that "fibers found on the victims appeared similar to fibers found in the Williams home and car and could have had a common origin." *Id.*

135. *Id.* at 821, 312 S.E.2d at 96 (Smith, J., dissenting). "The remaining facts and inferences were rank hearsay, unproven assumptions, and guesswork, and should not have been admitted by the trial court." *Id.* at 826, 312 S.E.2d at 99 (Smith, J., dissenting).

The admissibility of mathematically expressed probabilities should be subject to defined standards informing the trial court's discretion. For example, a showing that the expert's data and methodology are reliable could be required prior to admitting the probability evidence. This is the approach suggested by non-Georgia cases such as *State v. Sneed*<sup>136</sup> and by Justice Smith's dissent in *Williams*.<sup>137</sup> An alternative would be to require a preliminary finding that the probative value of the probability evidence is not outweighed by its prejudicial effect. There should also be express standards limiting the use of misleading probabilities in closing argument. In addition, requiring jury instructions which discourage excessive reliance on probability testimony or argument might reduce the potential for unfair confusion and distraction of the jury.<sup>138</sup> The Georgia Supreme Court's articulation of standards such as these would support an effective jury system and promote the fair administration of criminal justice.

*J. James Johnson*

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136. 76 N.M. 349, 354, 414 P.2d 858, 861-62 (Sup. Ct. 1966).

137. *Cf. Williams*, 251 Ga. at 821, 312 S.E.2d at 96 (Smith, J., dissenting) (stating that the prosecution failed to show the scientific validity of the experts' methodology).

138. The desirability of jury instructions was noted in *United States ex rel. DiGiacomo v. Franzen*, 680 F.2d 515, 519 (7th Cir. 1982). "The jury should . . . be made to understand that the [frequency of random occurrence] does not in any sense measure the probability of the defendant's innocence." Tribe, *supra* note 24, at 1355.