EVIDENCE: ADMISSION OF MATHEMATICAL PROBABILITY STATISTICS HELD ERRONEOUS FOR WANT OF DEMONSTRATION OF VALIDITY

In State v. Sneed *the New Mexico Supreme Court limited its disapproval of evidence of probability statistics to the particular facts presented but failed to articulate specific safeguards for subsequent use of such evidence. This note explores the nature of probability statistics, their potential utility in a legal context, and criteria by which their admissibility might be determined.*

THOUGH mathematical probability statistics were admitted in evidence in a federal court as early as 1866,[1] there is a paucity of appellate court opinion on the admissibility and proper function of such evidence.[2] A recent New Mexico case, *State v. Sneed*,[3] appears to be the vanguard of appellate consideration of probabilistic evidence introduced in criminal trials to link the defendant circumstantially with the crime. Rapidly increasing application of statistical techniques in all areas of decision making, including the inferential process,[4] assures recurrence of the problems inherent in juridical utilization of probabilistic evidence.

[1] *The Howland Will Case*, 4 AM. L. REV. 625, 648-50 (1870), involved mathematical probability in relation to the identity of disputed signatures. There was no judicial review of the evidence, however, as the case was disposed of on another point. Robinson v. Mandell, 20 Fed. Cas. 1027 (No. 11959) (C.C.D. Mass. 1868).

The juridical use of mathematical probabilities was discussed in several still earlier scholarly works. CONDORCET, ESSAI SUR L'APPLICATION DE L'ANALYSE À LA PROBABILITÉ DES DECISIONS RENDUES À LA PLURALITÉ DES VOIX (1785); DE MORGAN, FORMAL LOGIC (1847); POISSON, RECHERCHES SUR LA PROBABILITÉ DES JUGEMENTS EN MATIÈRE CRIMINELLE ET EN MATIÈRE CIVILE, PRÉCÉDÉES DES RÈGLES GÉNÉRALES DU CALCUL DES PROBABILITÉS (1837). See generally O'HARA & OSTERBURG, AN INTRODUCTION TO CRIMINALISTICS 678 (1949).

[2] Only two appellate cases deal with probabilistic evidence bearing directly on the primary issues presented for jury consideration: State v. Sneed, 414 P.2d 858 (N.M. 1966); People v. Risley, 214 N.Y. 75, 108 N.E. 200 (1915). See also Miller v. State, 240 Ark. 340, 399 S.W.2d 268 (1966); People v. Jordan, 45 Cal. 2d 697, 707, 290 P.2d 484, 490 (1955); People v. Trujillo, 32 Cal. 2d 105, 109, 194 P.2d 681, 684, *cert. denied*, 335 U.S. 887 (1948); Hendrick, *The Reality of Mathematical Processes*, in NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS, THIRD YEARBOOK 35, 40-41 (1928) (probalistic evidence formed basis for Dreyfus' conviction); *The Howland Will Case*, *supra* note 1; *Trials: The Laws of Probability*, Time, Jan. 8, 1965, p. 42 (statistics presented critically analyzed in Kingston, *Probability and Legal Proceedings*, 57 J. CRIM. L., C. & P.S. 93 (1966). See generally notes 49-55 *infra* and accompanying text.

[3] 414 P.2d 858 (N.M. 1966).

[4] Mathematical probability statistics are used widely in the social and physical sciences, in business, industry, and government, both as a research and as a decision-

Mr. and Mrs. Joe A. Sneed were shot and killed with a .22 caliber weapon.[5] Their son, Joe E. Sneed, charged with their murder, had allegedly purchased a .22 caliber revolver on the day prior to the homicides under the name "Robert Crosset," an alias that he was shown to have used at motels in other cities twice during the week before the deaths. The register of hand gun sales kept by the pawnshop where the gun in question was purchased indicated that the buyer, "Robert Crosset" of "Box 210, Las Cruces," was 5'9" tall and had brown eyes and brown hair.[6] The accused was of similar stature and coloring, but the pawnshop salesclerk was unable to make a positive identification at the trial.[7] To bolster the logical inference which the jury might draw from the foregoing evidence,[8] the state, over objection, introduced the testimony of a professor of mathematics to the effect that the odds were 240 billion to one that Sneed was "Robert Crosset," the gun purchaser.[9] From a conviction of first degree murder, the defendant appealed, urging, in addition to other allegations of error, the inadmissibility of probabilistic evidence.[10] The New Mexico Supreme Court found that an inadequate foundation laid for the expert's conclusions left it unable to review that portion of the record without resort to speculation, and this deficiency, coupled with improper comment to the jury by the state, was deemed sufficiently prejudicial to warrant retrial of the accused.[11]

Although the court's holding seemingly posits the admissibility

making tool. See generally ABSTRACT SERVICE, QUALITY CONTROL AND APPLIED STATISTICS (1967).

[5] Brief-in-Chief of Appellant, p. 8, State v. Sneed, 414 P.2d 858 (N.M. 1966).

[6] 414 P.2d at 860.

[7] Brief-in-Chief of Appellant, p. 12.

[8] The inference might be deduced as follows: Few people are named Robert Crosset. Fewer still are 5'9" tall, have brown eyes, brown hair, and the name Robert Crosset. The accused is 5'9" tall, has brown eyes, brown hair, and has used the name as an alias. *Ergo,* he could be the person who purchased the gun. Further, a sales slip which testimony indicated was for ammunition that would fit the gun and that was purchased on the same day and in the same town as the gun, was found during a search of the accused's car. Brief-in-Chief of Appellant, pp. 12-13. From this the inference can be drawn that the accused might have been in Las Cruces on the day the gun was purchased, and might have purchased the ammunition. *Ergo, satis veri simile est* the accused is Robert Crosset, the gun purchaser.

[9] 414 P.2d at 861.

[10] Brief-in-Chief of Appellant, p. 15. The other grounds for appeal were improper comment to the jury during argument concerning the accused's failure to testify, and the admission of evidence which was the product of an allegedly illegal search. *Ibid.*

[11] 414 P.2d at 860-62.

of probabilistic evidence where an adequate foundation for admission has been laid,[12] the court failed to detail the prerequisites to the employment of such evidence. Moreover, the *Sneed* decision did not reach certain fundamental questions such as the relevance of probabilistic evidence in any given case; its value when balanced against potential prejudicial impact on a jury; and the availability of procedural safeguards to assure its valid use. Before these various legal issues can be intelligibly explored, however, an understanding of the inferential process and the nature of probabilistic evidence is necessary.

An inference, an inherent function of any conclusion based on circumstantial evidence,[13] is a logical deduction derived by comparing similarities or common traits in two bodies of data, about one of which certain conclusions have already been reached, and from the other of which a conclusion is desired.[14] The greater the similarity between the two bodies of data, the stronger is the inference of their identity.[15] Since a close and comprehensive comparison of two bodies of data is seldom possible, comparison is usually made of the unique traits of the data.[16] The more unique a trait or combina-

[12] The *Sneed* court noted that "the problem is in determining *when* a scientific principle is sufficiently developed to be used in evidence. . . . We hold that mathematical odds are not admissible as evidence to identify a defendant in a criminal proceeding *so long as* the odds are based on estimates, the validity of which have not been demonstrated." *Id.* at 861-62. (Emphasis added.)

[13] See BURRILL, CIRCUMSTANTIAL EVIDENCE 80-82 (1868); 2 WIGMORE, EVIDENCE § 411 (3d ed. 1940) [hereinafter cited as WIGMORE, EVIDENCE]; Kingston, *supra* note 2, at 93; Kingston & Kirk, *The Use of Statistics in Criminalistics*, 55 J. CRIM. L., C. & P.S. 514 (1964); Mode, *Probability and Criminalistics*, 58 J. AM. STATISTICAL ASS'N 628 (1963).

[14] The inferential process may be illustrated as followers: Two bandits wearing Halloween masks left the scene of the crime in a brown car (data about which certain conclusions have already been reached). Five minutes later and a few miles away, two men in a brown car are stopped. On the front seat are two Halloween masks and a sum of money equal to that taken (data from which a conclusion is desired). Are these the criminals? The inference that they are seems warranted, subject, of course, to refutation. See, *e.g.*, Commonwealth v. Whitman, 199 Pa. Super. 631, 634, 186 A.2d 632, 633 (1962); 2 WIGMORE, EVIDENCE § 411.

[15] *Ibid.* See generally BURRILL, *op. cit. supra* note 13, at 146-95.

[16] In People v. Hanson, 31 Ill. 2d 31, 39-40, 198 N.E.2d 815, 819-20 (1964), for example, the "peculiarity" of a heel print served to corroborate the confession of an accused murderer whose heel matched heelprints found at the scene. In another case, testimony that the accused lived in Atlantic City and that a blue station wagon was registered in his wife's name was held relevant in identifying the accused as an abortionist where a patient recalled that her abortionist lived in Atlantic City and drove a blue car. Basoff v. State, 208 Md. 643, 652, 119 A.2d 917, 922 (1956). An "unusual" tire track corroborated a dying declaration made by the murder victim in State v. Brown, 263 N.C. 327, 336, 139 S.E.2d 609, 614 (1965). Evidence that impressions on the tumbler of a burglarized safe matched those produced by a punch found in a 1963 maroon-and-cream

tion of traits is, that is, the less frequently it occurs in a given "population,"[17] the more probable it is that a later occurrence of an identical trait, or combination of traits, was produced by the same source which produced an earlier observed instance of the specified trait.[18]

The link between one accused of a crime and the crime itself is forged by this logical process of individualization. The criminal usually leaves *some* trace of himself at the scene of a crime: a tool mark, fingerprint, bullet, or perhaps a thought impression in the mind of a witness.[19] By connection this "trace" with its producer, the criminal may be identified. In drawing a connecting inference and in giving it weight, a witness and/or the jurors subjectively estimate the probability that their conclusion is correct[20] by testing "similarity of occurrence" and "uniqueness of trait" against the background of their own limited experience.[21]

Cadillac with Maryland license plates was admitted to link the accused owner of the car with the burglary where a car meeting that description was seen near the scene of the crime. State v. Hamilton, 264 N.C. 277, 141 S.E.2d 506 (1965), *cert. denied*, 384 U.S. 1020 (1966). See also Osterburg, *An Inquiry into the Nature of Proof*, 9 J. FOR. SCI. 413 (1964).

[17] "From a statistical point of view, a *population* or, as it is sometimes called, a *universe* is the totality of elements that have one or more characteristics in common. A population is said to be *specified* when the common characteristics which define it have been specified." HUNTSBERGER, ELEMENTS OF STATISTICAL INFERENCE 88 (1961).

[18] See BENTHAM, 3 RATIONALE OF JUDICIAL EVIDENCE 219-21 (1827); WIGMORE, SCIENCE OF JUDICIAL PROOF § 151, at 259 (3d ed. 1937); Mode, *supra* note 13, at 629. See generally Kingston, *Application of Probability Theory in Criminalistics* (pts. 1-2), 60 J. AM. STATISTICAL ASS'N 70, 1028 (1965).

In *Sneed*, the data recorded on the register of handgun sales presumably represents a recorded observation of certain of the gun purchaser's traits. The appearance which the accused presented to the jury at the trial is a later occurrence of a combination of traits common to both the accused and the gun purchaser.

[19] See, *e.g.*, State v. Post, 255 Iowa 573, 583, 123 N.W.2d 11, 17 (1963); Kingston, *Application of Probability Theory in Criminalistics*, 60 J. AM. STATISTICAL ASS'N 70, 71 (1965); Mode, *supra* note 13, at 629.

[20] A witness testifying to recoguition of the defendant, for example, bases his testimony on an inference, which is in turn based on his finding of substantial similarity between the first observation and the in-court observation. See KIRK, CRIMINAL INVESTIGATION 21-22 (1953); 2 WIGMORE, EVIDENCE § 411, at 386; *id.* § 413, at 387. The jurors infer the truth of the witness' statement, or draw a connecting inference themselves in the case of circumstantial evidence, where they base their verdict in whole or in part upon that evidence. See, *e.g.*, People v. Yokum, 145 Cal. App. 2d 245, 250-51, 302 P.2d 406, 410 (Dist. Ct. App. 1956). Graham v. State, 239 Md. 521, 212 A.2d 287 (1965) (heelprint at scene of crime which matched heelprint produced by defendant's shoe warranted inference that defendant was at scene of crime).

[21] Subjective estimates of probability appear to be based to a large degree on psychological considerations, rather than upon potentially more objective mathematical axioms of probability. See Cohen, *Subjective Probability*, Scientific American, Nov. 1957, p. 128.

A mathematically computed probability statistic, an objectively drawn assessment of "uniqueness," is based upon a census or sample survey,[22] intentionally inclusive in scope, and potentially broader and more precise than a person's remembered experiences which ordinarily form the basis for one's inferences. Probability, defined loosely, is the likelihood, based on repeated trials or collected past experience, that any particular segment of a population will have a characteristic known to be present within that population.[23] Statistically, the probability of occurrence of a particular characteristic within a population equals the relative frequency of its occurrence—that is, the frequency with which it occurs in that population divided by the size of the population.[24] The relative frequency of occurrence of a complex object, with which several characteristics might be associated, can sometimes be gauged by applying the "multiplication rule."[25]

"Suppose a number of witnesses testify that they saw a man thrust his hand into a bucket of water, and on taking it out a hole remained in the water where the man's hand had been. It matters not how positive and direct such testimony was, no sane jury would accept it. Why? Because their past experience, based upon circumstances, teaches them that it is contrary to the laws of nature . . . .

. . . .

Every man's experience demonstrates that his beliefs are based upon a great number of circumstances . . . which, when combined together, give strength to each other . . . ." *Ex parte* Jefferies, 7 Okla. Crim. 544, 546, 551, 124 Pac. 924, 925, 927 (1912). See Kingston & Kirk, *supra* note 13, at 515.

Osterburg sampled experts in an attempt to discover the degree of accuracy resulting from the subjective evaluation of the significance of only a few characteristics of a fingerprint. Such subjective evaluation, he found, "clearly . . . is suspect." Osterburg, *supra* note 16, at 425. Subjective estimates of probability may not conform to an "objectively" derived estimate, if obtainable, in many situations. Thus an objective estimate upon which to base an inference may be the more desirable.

[22] A census or sample survey defines the frequency of occurrence of certain traits or characteristics within a surveyed population.

[23] For an interesting quasi-statistical application of the relative frequency process to the concept of reasonable doubt, see Commonwealth v. Watts, 179 Pa. Super. 398, 403-07, 116 A.2d 844, 847-48 (1955) (Woodside, J., dissenting). See also Kesselring v. Hummer, 130 Iowa 145, 106 N.W. 501 (1906); Young v. Johnson, 123 N.Y. 226, 25 N.E. 363 (1890).

[24] The probability of the occurrence of a characteristic may also be expressed as the ratio of favorable outcomes to total outcomes. To illustrate: a survey is made of a population composed of 100 women. Fifty are found to have brown hair. The probability that any one of the women in that population, selected at random, will have brown hair is equal to the frequency of the occurrence divided by the size of the population. [$\Pr(A) = \frac{f(A)}{n}$; $\Pr(\text{brown hair}) = \frac{50}{100} = \frac{1}{2} = .5$.] The combined probability of having brown hair and not having brown hair equals 1. [$\Pr(A) + \Pr(\text{not } A) = 1$.] See HUNTSBERGER, *op. cit. supra* note 17, at 68, 75, 78. See generally Kingston, *Probability and Legal Proceedings*, 57 J. CRIM. L., C. & P.S. 93, 94 (1966).

[25] The probability of the joint occurrence of two *independent* traits is the product

The first step in calculating a probability statistic is the selection of the population in which one is interested, against which the degree of "uniqueness" of a particular characteristic will be gauged. The *true* population of interest is the criminal who left the "trace" that links him with the crime, but seldom can he be conclusively identified. The criminal, however, is also a member of a larger population, those persons who could have committed the crime.[26] By establishing the frequency with which characteristics common to the accused and the criminal occur in this population of interest one may better gauge the likelihood that the accused actually committed the crime.[27] If characteristics common to both an accused

of their individual probabilities of occurrence. $Pr(A)Pr(B) = Pr(AB)$. A trait is said to be independent of a second trait when the occurrence or non-occurrence of one does not affect the probability of the occurrence of the other trait. The multiplication rule cannot be used without some degree of error where the traits are not independent. HUNTSBERGER, *op. cit. supra* note 17, at 77; Kingston & Kirk, *supra* note 13, at 516.

Often this problem can be avoided by sampling for the combined occurrence. For example, brown eyes and brown hair may not be independent traits. Instead of sampling for brown eyes, and for brown hair, and multiplying to find, perhaps inaccurately, the frequency of their joint occurrence, the trait of joint occurrence of both characteristics could be surveyed. *Cf. id.* at 518-20.

Though both McCormick and Wigmore enthusiastically note the potential uses of probabilistic evidence, neither acknowledges this restriction on the multiplication rule. See MCCORMICK, EVIDENCE § 171 (1954) [hereinafter cited as MCCORMICK]; WIGMORE, *op. cit. supra* note 18, § 154.

State v. Sneed illustrates the multiplication rule's potential for misuse. The expert "estimated" that the name "Robert" occurred once in thirty names and that "Crosset" would occur once in one million names, see note 32 *infra*. Thus, reasoned the expert, "Robert Crosset" would occur once in thirty million names. Since given names are often not independent of surname, that is, they occur more frequently in some families than in others, the application of the multiplication rule in this instance is suspect.

[26] Discussion in this note, for the sake of simplicity, is framed in terms of a trace directly associated with the crime, for example, the physical characteristics of the criminal as described by an eyewitness. The link might often be indirect, however, requiring additional evidence and several inferences to identify the accused as the criminal. Probabilistic evidence could nevertheless still be of value in such situations. In *Sneed*, for example, the gun purchased by "Robert Crosset" was never conclusively shown to be the murder weapon; but "proving" that the accused purchased a weapon of the same caliber as that used in the killings would be of some probative value where the accused disclaimed any such purchase.

[27] The sales slip offered by the prosecution may establish Sneed's presence in Las Cruces on the day of the gun purchase. See note 8 *supra*. He was later shown to be a 5'9" brown-eyed, brown-haired "Robert Crosset," a description which also fit the gun purchaser. To determine whether or not the accused is "Robert Crosset," the degree of "uniqueness" of the linking traits must be gauged against the population that could have purchased the gun. If the accused was the only person in town that day with the particular characteristics, he must necessarily have been the gun purchaser. Since it is likely that the gun purchaser was from the vicinity of Las Cruces and since this area could also serve as a *rough* estimator of the frequencies on a national scale,

drawn from this population and the criminal are found to be unique to him within this population of interest, one may properly infer that the accused *is* the criminal. This will rarely be the case, though, for it is unlikely that the data available would indicate one individual as the truly unique possessor of particular characteristics;[28] thus other evidence will be necessary to link the accused with the crime. Probabilistic evidence obviously could be profitably employed in conjunction with such other evidence, however.

As a mechanical matter, since it is seldom possible to survey an entire population to determine the frequency with which a characterstic occurs, the degree to which a characteristic is "unique" must often be "estimated"[29] by sampling from the larger population. In sampling, a *mathematicaly random*[30] selection of individuals from the "population of interest," whose characteristics are thereafter catalogued, will produce an estimate which is free from bias[31] of the

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the population of the area in and around Las Cruces was selected as an "estimator" (see note 29 *infra* and accompanying text) of the people in town on the day that the gun was purchased. The purchaser *could* have been a traveler from another part of the nation, however, and as a check on the effect which this possibility would have on the final "uniqueness" or frequency estimate, a national survey of various evidential characteristics and traits would be helpful. *Cf.* Kingston & Kirk, *supra* note 13, at 520.

[28] At present, data is available on only a limited number of characteristics. See *ibid.* Thus, if a robber were known to have brown hair, a heart-shaped tattoo on his right hand, and green eyes, and an individual with those characteristics were located, it would presently be statistically impossible to show the "uniqueness" of those characteristics, *i.e.*, the frequency with which they occur.

[29] In most sets of data, observed characteristics tend to group around some value within the data set. See generally DIXON & MASSEY, INTRODUCTION TO STATISTICAL ANALYSIS 15-30 (1951). The most common measure of this value is the mean, or average. Sampling to estimate the true nature of a population makes use of this tendency. Imagine a population composed of 1,000 women. One hundred are *randomly* selected from it and surveyed. Fifty are found to have brown hair. Within that sample Pr (brown hair) = .5. See note 24 *supra*. After returning that 100 to the population, 100 are again randomly selected. Pr (brown hair) is found to be .4. This process is repeated, and values of .5 and .6 are obtained. By averaging all these values one can "estimate" the Pr (browu hair) in the total population to be .5. This is the most elementary and imprecise form of "true value" estimation, but serves to illustrate the "estimation" concept. For this as well as for more complex forms of estimation, formulas exist by which the accuracy of such estimation for various sample sizes can be "estimated." See generally LI, INTRODUCTION TO STATISTICAL INFERENCE 23-42 (1957); MEYER, INTRODUCTORY PROBABILITY AND STATISTICAL APPLICATIONS 261-88 (1965).

[30] A random sample is "one selected in such a way that every pair of elements is statistically independent. . . . In everyday terms, a sample is random if every element in the population has an equal and independent chance of being selected." HUNTSBERGER, *op. cit. supra* note 17, at 91. See GOOD, PROBABILITY AND THE WEIGHING OF EVIDENCE § 4.7, at 38 (1950).

[31] Statistically, bias is the tendency of an estimate to deviate in one direction from the true value sought to be estimated.

investigator.[32] In addition to randomness, the sample must accurately reflect the population from which it was drawn to eliminate all inaccuracy.[33] Quite logically, the larger the proportion of the total population sampled, the more accurate the estimate of the frequency of occurrence of a characteristic will be; but even a relatively small sample can give reasonably accurate results, and the degree of accuracy itself can often be "estimated."[34]

The product of this abstraction process, a mathematically computed "estimate of probability," represents an appraisal of the "uniqueness" of a particular characteristic which will often more

[32] See HUNTSBERGER, *op. cit. supra* note 17, at 91; LI, *op. cit. supra* note 29, at 1. Systematic sampling is an alternative to, and is often combined with, random sampling. In some cases, systematic sampling can be more accurate than random sampling, but by its nature a systematic sample requires assumptions about the population sampled. This factor can introduce unwarranted bias into the final statistic. Further, "nearly all theoretical development of statistical techniques has the element of randomness as a basic assumption." HUNTSBERGER, *op. cit. supra* note 17, at 91.

The *Sneed* expert attempted to estimate the frequency of occurrence of the name "Robert Crosset" within the population in and around Las Cruces by a survey of the telephone books of "various western communities." 414 P.2d at 860-61. For more common names the telephone book might serve as a reasonably accurate "estimator"; but the sample would be of questionable value if one household having an infrequently occurring name such as "Crosset" did not have a telephone. The expert in *Sneed* found no "Crossets," and his choice of a once-in-a-million occurrence of the name "Crosset" was not a calculated "estimate" in the statistical sense of that word.

The final calculations of the expert also included the *mathematically valid* calculation that the probability of any one number being randomly chosen from 1,000 numbers is one in 1,000. *Id.* at 861. The expert assumed that the selection of a post office box number (the gun purchaser gave his address as Box 210) was the equivalent of the random selection of one number from 1,000. Even if this is logically so, and arguably it is not, for number selection may not be a random process, such a statistic has relevance only if it is linked with the accused, as was done wtih the alias "Robert Crosset." The record does not indicate that any link between the accused and the box number was established; and the use of this factor further distorted (by a factor of 1,000) the conclusion of the expert.

[33] The sample chosen by the *Sneed* expert upon which to estimate height, and hair and eye color did not accurately reflect the population of interest, those individuals who could have purchased the gun. The expert's estimates of the frequency occurrence of brown hair, brown eyes, and a height of 5'9" were based solely on the data in the register of gun sales. 414 P.2d at 861. A sample size of thirty-five could be statistically shown to be inadequate to "estimate" accurately the characteristics of the population of interest here. For a mathematical test which may be employed to indicate that the *Sneed* statistic is of no evidential significance, see Kingston, *Probability and Legal Proceedings*, 57 J. CRIM. L., C. & P.S. 93, 95 (1966). Further, logical analysis readily confirms that the gun-purchasing patrons of one pawnshop do not represent a valid cross section of the population of interest. Bias resulting from selection of the sample to include the gun purchaser may have been in Sneed's favor, however, for it increased the frequency of occurrence of the enumerated traits, thus decreasing their "uniqueness."

[34] See note 38 *infra*. See generally MEYER, *op. cit. supra* note 29, at 261-88.

closely parallel the true "uniqueness" of that characteristic than would an individual's estimate based solely on personal experience. Since the identification process *is* one of individualization, the inference process one of estimating "uniqueness," the validity of an inference drawn is directly related to the accuracy with which the frequency of occurrence of connecting traits is estimated. Subjective estimates may often be inaccurate.[35] Thus, the value of accurate statistical analysis, where it can be made, lies in the relative definitude with which a probability statistic can portray the frequency of occurrence of a characteristic and in the ability of statistical analysis, in some instances, to predict the existence in the population of interest of more than one possible source of a "trace" left by the party who committed the crime.[36] When offered for these ends, probabilistic evidence based on sound premises and accurate data is logically relevant,[37] for by relating the accused to the population of interest, the class within which the criminal is to be found, rational persuasion may be effected, and inferences more precisely drawn.[38]

[35] See note 21 *supra*. See also Korn, *Law, Fact, and Science in the Courts*, 66 COLUM. L. REV. 1080, 1110-11 (1966).

[36] Dr. Charles Kingston of the New York State Identification and Intelligence System has developed formulas by which the "probability of duplication"—the probability that, given the existence of one source capable of producing an evidentiary trace, a second source exists—may be estimated in certain situations. See Kingston, *Application of Probability Theory in Criminalistics*, 60 J. AM. STATISTICAL ASS'N 1028 (1965); Kingston, *Probability and Legal Proceedings*, 57 J. CRIM. L., C. & P.S. 93 (1965). The Kingston statistic, since it relates the frequency estimate to the population of interest, is often more probative than the naked frequency estimate espoused by McCormick and Wigmore, see note 25 *supra*. Further, it overcomes other problems inherent in the elemental frequency estimate. See note 38 *infra*.

[37] See, *e.g.*, State v. Kieon, 93 R.I. 290, 293-94, 175 A.2d 284, 286-87 (1961); 1 WIGMORE, EVIDENCE § 9, at 289.

[38] If statistical analysis indicates that the characteristics common to both the criminal and the accused occur but once in one million individuals, ipso facto the inference that the accused is the criminal is more warranted than if the characteristics occurred once in ten thousand individuals in the same population. The relative frequency estimate by itself, however, gives no indication of how much more warranted the inference is. The statistic *must* be related to the population size to give it meaning. If the population of interest consists of one million individuals, and the frequency of occurrence of the linking characteristics *actually is* once in one million individuals, then the accused is necessarily the criminal. If the frequency is once in ten thousand, then any one of one hundred individuals in that population could be the criminal. Other evidence connecting the accused with the crime would be necessary before it could be determined that he is the criminal.

If a naked relative frequency statistic is offered to the jury, as was the case in *Sneed*, jurors *may* be able to interpret the statistic against their own subjective concept of the population involved, similarly as an expert does when he uses an explicitly

From the foregoing discussion, it can readily be seen that the use of probabilistic evidence necessitates employment of a skilled witness.[39] The Anglo-American judicial system, recognizing the limited experience of the fact-finder, has long made provision for such expert assistance to aid in analyzing collected evidence.[40] Inferences which the average juror would be incompetent to draw may be deduced from evidence by an expert;[41] and often, facts which might otherwise go unnoticed or be deemed irrelevant are connected to a proponent's scheme of proof through "expert" analysis.[42]

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drawn probability statistic to check his own subjectively drawn inference about certain evidence. See note 42 *infra*. It seems unlikely, however, that a jury would be sufficiently sophisticated to interpret the statistics with a high level of validity.

Two alternatives appear, though at present, one is unavailable. Expert opinion, based on probabilistic evidence, that the accused *is* the criminal or did some act with which the criminal is associated (such as, in *Sneed*, purchase a gun) would undoubtedly be proscribed at the present time as a matter not properly the subject of expert testimony. *Cf.* Lindsey v. United States, 237 F.2d 893 (9th Cir. 1956). The present state of the statistical art makes this the proper result, see text accompanying note 77 *infra*. As data gathering techniques and analytical ability develop, however, this form of opinion evidence may become as reliable as ballistics or fingerprint evidence. In light of the origins of the "expert opinion" exception to the "opinion rule" (see generally 7 WIGMORE, EVIDENCE § 1917) and the admissibility of other expert opinion evidence, admissibility of such opinions would then seem proper.

The second alternative, a statistic such as the one developed by Dr. Kingston, see note 36 *supra*, avoids the above mentioned problems, however, for it does relate the relative frequency figure to the population. This type of statistic seems valuable to assist the jury in weighing inferences, and unless excluded in any given case for discretionary reasons, see notes 59-69 *infra* and accompanying text, could be validly admitted.

[39] In most cases probabilistic evidence will best be treated as expert opinion, and subject to the limitations typically placed upon that form of evidence. See generally 2 WIGMORE, EVIDENCE §§ 555-62. Though, unlike some expert conclusions, the inference to be drawn from a probability statistic is a matter exclusively within the purview of the jury, see note 38 *supra*, and though a probability statistic will presumably be grounded in fact, the numerous assumptions required to select the factors to be treated, and to reduce the data to mathematical abstraction bring probabilistic evidence within the expert opinion evidential class. *Cf.* MEYER, *op. cit. supra* note 29, at 1.

[40] See generally 7 WIGMORE, EVIDENCE §§ 1917-18, 1923.

[41] For example, few jurors are sufficiently familiar with physiology to assess "probable cause of death," even if it were possible to lay all the facts before them; but a physician, or in some instances, a mortician, Anglin v. State, 222 Ga. 9, 148 S.E.2d 390 (1966), will have had sufficient experience or training to do so. Compare Kesselring v. Hummer, 130 Iowa 145, 106 N.W. 501 (1906); Young v. Johnson, 123 N.Y. 226, 25 N.E. 363 (1890).

[42] See, *e.g.*, People v. Trujillo, 32 Cal. 2d 105, 109-10, 194 P.2d 681, 683-84, *cert. denied*, 335 U.S. 887 (1948) (screwdriver marks and certain fibers linked accused with murder); Graham v. State, 239 Md. 521, 527-29, 212 A.2d 287, 289-91 (1965) (heelprint and ballistics test led to murder conviction).

In substance, an expert's analysis is identical with the thought process of any

The test of the admissibility of expert testimony has been expressed in numerous ways.[43] In application, the "true criterion" of admissibility has been said to be: "On *this subject* can a jury from *this witness* receive appreciable help."[44] Qualification of a witness as an expert in a particular subject area is usually sufficient to gain admission of his opinions on matters within his specialty.[45]

layman. Though based on more specialized knowledge than an inference drawn by a layman, an inference drawn by an expert is just as implicitly based upon probability concepts. The fingerprint expert, for example, who testifies that the prints of the accused were found at the scene of the crime does not testify with actual knowledge that the accused was the source of the fingerprints, but instead bases his conclusion on the probability that no two people have identical fingerprints. See KIRK, *op. cit. supra* note 20, at 20-21; O'HARA & OSTERBURG, *op. cit. supra* note 1, at 666; 2 WIGMORE, EVIDENCE § 414, at 389. Testimony concerning the identity of fiber or hair belonging to the accused is based on similar grounds: the probability, sometimes explicitly calculated, that no other person wearing fiber from the same mill and dye lot, or with hair which reacts identically to that of the accused, was at the scene of the crime. See People v. Trujillo, *supra*; Kirk & Kingston, *Evidence Evaluation and Problems in General Criminalistics*, 9 J. FOR. SCI. 434, 438, 442-43. Testimony on the probability of pregnancy on first intercourse, see Kesselring v. Hummer, *supra* note 41 (excluded); Young v. Johnson, *supra* note 41 (admitted), or the probable position of the attacker, see State v. Buralli, 27 Nev. 41, 71 Pac. 532 (1903), or the probable cause of death, see note 41 *supra*, is also no more than an inference, based on an interpolation from the testificant's own experience in the area of his specialty and upon the collected experience of others transmitted to him.

[43] See, *e.g.*, United States v. Alker, 260 F.2d 135, 155 (3d Cir. 1958); Commonwealth v. Evans, 190 Pa. Super. 179, 253, 154 A.2d 57, 95 (1959); MCCORMICK § 13, at 28; 2 WHARTON, CRIMINAL EVIDENCE § 502, at 324 (1955), 62 (1966 Supp.).

[44] 7 WIGMORE, EVIDENCE § 1923, at 21.

[45] See, *e.g.*, State v. Hinkle, 6 Iowa 380, 386 (1858); Commonwealth v. Spear, 143 Mass. 172, 9 N.E. 632 (1887); Commonwealth v. Sturtivant, 117 Mass. 122, 138 (1875); Lindsay v. People, 63 N.Y. 143 (1875). *The Howland Will Case*, 4 AM. L. REV. 625 (1870).

Expert testimony has often been excluded "where the jury are equally capable of drawing the conclusion sought from [the] expert witness . . . ." Commonwealth v. Gardner, 216 N.E.2d 558, 560 (Mass. 1966). Care must therefore be taken to distinguish the data underlying the expert's conclusion (to which the expert will in some cases become a testificant) from the opinion of the expert about conclusions to be derived from that data, for every expert opinion is merely a condensate of underlying data stated in the form of a conclusion. Objection on "opinion rule" grounds to the conclusions of an expert about probability evidence would seem proper whenever *that condensate*, the inferences and conclusions about the underlying data, could be drawn *as well* by the jury as by the witness, Commonwealth v. Gardner, *supra*. However, a computed statistic can arguably constitute relevant evidence (see notes 37-38 *supra* and accompanying text) and a probability statistic is *not* a conclusion that the jury could draw equally well. Thus, assuming that an expert qualified in the subject matter computes the statistic or presents evidence from which another statistician computes it, objection to the probabilistic evidence would be proper only on such grounds as lack of relevancy, undue potential prejudice, tendency to mislead the jury, or undue consumption of time in presentation. See notes 59-69 *infra* and accompanying text. If the proponent of probabilistic evidence can show relevancy and can meet other challenges of the opponent, the "opinion rule" should not obstruct the introduction of this type of evidence.

However, when his conclusions are presented to the fact-finder as the product of a scientific process or device which is not sufficiently accepted that judicial notice of it may be taken,[46] the "misleading aura of certainty"[47] which tends to surround such evidence has resulted in an additional limitation on its use. Where the device or process is not generally known and accepted, the proponent must *both* qualify the expert and show the relevancy of the proffered evidence by demonstrating to the court that the process can and does produce the relevant conclusions which the expert asserts that it produces.[48]

To date, appellate review of the application of the qualification standards to probabilistic evidence has been minimal. *People v. Risley*,[49] long the only appellate decision involving mathematical probabilities offered as evidence bearing directly on the issues in the case,[50] turned upon the matter of qualification. The New York

[46] Cognizance of matters generally known and accepted may be taken by a court through the process of "judicial notice," thus eliminating the necessity for formal proof of such matters. Everight v. City of Little Rock, 230 Ark. 695, 326 S.W.2d 796 (1959) ("radar"); State v. Tomanelli, 216 A.2d 625, 628 (Conn. 1966) (Doppler effect, upon which police "radar" is principled); State v. Johnson, 42 N.J. 146, 172, 199 A.2d 809, 823 (1964) (court implicitly noted accuracy of "drunkometer"); 9 WIGMORE, EVIDENCE § 2565. Judicial notice is not conclusive, and the opponent of notice may dispute the proposition noted. State v. Tomanelli, *supra*; 9 WIGMORE, EVIDENCE § 2567. The validity of a new principle, process, or device in its early stages cannot be judicially noted, but with common use and general acceptance of its accuracy, a court may take judicial notice of it. Call v. City of Burley, 57 Idaho 58, 73, 62 P.2d 101, 107 (1936) (X-ray); State v. Walker, 37 N.J. 208, 181 A.2d 1 (1962) (polygraph, reliability not judicially noted); State v. Greul, 59 N.J. Super. 34, 38, 157 A.2d 44, 46-47 (Union County Ct. 1959) (drunkometer); see WIGMORE, EVIDENCE § 2567, at 535. A court may take judicial notice of a fact without a request that it do so, for the propriety of judicial notice is increasingly a matter of trial court discretion. United States v. Harris, 331 F.2d 600, 601 (6th Cir. 1964); State v. Ladd, 252 Iowa 487, 490, 106 N.W.2d 100, 101 (1960) (dictum); UNIFORM RULE OF EVIDENCE 9.

[47] Huntingdon v. Crowley, 64 Cal. 2d 647, 656, 414 P.2d 382, 390, 51 Cal. Rptr. 254, 262 (1966).

[48] See, *e.g.*, Commonwealth v. Sousa, 215 N.E.2d 910, 913 (Mass. 1966); State v. Johnson, 42 N.J. 146, 199 A.2d 809 (1964) (by implication); cases cited note 60 *infra*.

[49] 214 N.Y. 75, 108 N.E. 200 (1915), 28 HARV. L. REV. 693, 13 MICH. L. REV. 702.

[50] By probabilistic evidence directly bearing on the issues in the case is meant a probability statistic offered by an expert concerning circumstantial evidence about which he himself states no conclusions. The statistic offered in *Sneed* is such a statistic. This is to be contrasted with a probability statistic elicited from a scientific expert during examination as to the basis for his conclusions concerning real evidence. Probabilistic evidence is currently admissible in the latter situation. See Miller v. State, 240 Ark. 340, 399 S.W.2d 268 (1966) (by implication); People v. Jordan, 45 Cal. 2d 697, 707, 290 P.2d 484, 490 (1955) (seven matching fibers; probability of one in 1,280,000,000 that defendants acquired fibers from other than bodily contact with deceased individual) (trial testimony recounted in HOUTS, FROM EVIDENCE TO PROOF

Court of Appeals, however, did not distinguish between the prongs of the qualtification test[51] in refusing to allow the admissibility of proffered testimony concerning the probability of the joint occurrence of a number of defects in typography which occurred on two typewritten sheets alleged to have been produced on the same machine. The *Risley* court found that the witness was not an expert in typewritten documents, that he had not made a study of such, and that he had not considered the variables that might influence the result; consequently, his conclusions, "not based on actual observed data," were "simply speculative."[52]

The New Mexico Supreme Court in *State v. Sneed* clearly based its holding upon the second half of the qualification test, validation of the process employed by the expert. Finding that the probabilistic process was "not of such common knowledge that [they could] . . . take judicial notice" of it[53] and that the inadequate record would require them "to speculate as to the validity" of the statistics,[54] the court held that mathematical odds are inadmissible where based on estimates of undemonstrated validity.[55] Thus, the qualification test applied in both *Sneed* and *Risley* forces the state, as proponent, to set out at length the mathematical principles and the data upon which probability calculations have been based, as well as the rationale for selection of the particular data used, or face reversal on appeal.

In order to lay a foundation for the introduction of probabilistic evidence, the proponent should show the wide usage, in both social and physical science, of frequency estimates and statistics derivative thereform.[56] Additionally, he should establish the relevancy of the

134 (1956)); People v. Trujillo, 32 Cal. 2d 105, 109, 194 P.2d 681, 684, *cert. denied*, 335 U.S. 887 (1948) (eleven matching fibers; probability of 100 trillion to one of contact) (trial testimony recounted and critically reviewed in HOUTS, *op. cit. supra*, at 325-29); People v. Houser, 85 Cal. App. 2d 686, 691, 193 P.2d 937, 940 (Dist. Ct. App. 1948). The additional safeguards discussed in the text accompanying notes 70-75 *infra* seem less necessary in connection with this latter use of probabilistic evidence, for the criminalist whose continued employment depends upon his reputation for reliability and accuracy within his area of competence seems unlikely to risk this reputation by an ill-founded or careless use of statistics to support his conclusions. See also Conrad, *The Expert and Legal Certainty*, 9 J. FOR. SCI. 445, 450 (1964).

[51] See text accompanying note 48 *supra*.

[52] 214 N.Y. at 85, 108 N.E. at 202-03.

[53] 414 P.2d at 861.

[54] *Ibid.*

[55] *Id.* at 861-62.

[56] Wide usage evidences reliability in the minds of some courts, and assists in

evidence to be offered, coupling an explanation of the frequency estimation process with the data upon which the estimate is based.[57] For the criminal defendant offering such evidence, the foundation need only be sufficiently detailed to convince the trial court of its admissibility, for if the defendant is successful, the adequacy of the foundation laid by him and of cross-examination by opposing counsel will seldom be subject to review.[58] Where the proponent is the state, however, the foundation must be sufficient to withstand appellate review, as well as to gain admission in the trial court.

Qualification of the expert and demonstration of the validity of the process applied by him, while prerequisite to the admission of probabilistic evidence, do not compel that result. Exclusion of relevant circumstantial evidence which tends to confuse the issues or prejudice the opponent "in excess of its legitimate probative weight"[59] is within the sound discretion of the trial court, subject to appellate review and reversal for excess.[60] Additionally, within

overcoming the remaining vestiges of the "general scientific acceptance" standard, see note 61 *infra*. *Cf.* Medley v. United States, 155 F.2d 857, 860 (D.C. Cir. 1946).

[57] It has been suggested that counsel seeking to introduce extraordinary evidence confer with the court beforehand, outlining the nature of the evidence and its relevancy. Gordon, *The Use of Scientific Evidence and its Legal Limitations*, 9 J. FOR. SCI. 301, 310 (1964). This procedure avoids the danger that the court, unsure of the offer, will opt for exclusion, rather than admit the evidence and commit what may be a reversible error.

[58] In most jurisdictions the state cannot appeal from the acquittal. See generally MODEL PENAL CODE § 1.09, comment (Tent. Draft No. 5, 1956). Therefore, no appellate review will be had of a trial court's exercise of discretion in allowing the successful defendant to offer probabilistic evidence.

[59] 6 WIGMORE, EVIDENCE § 1904, at 574.

[60] *E.g.*, United States v. Bowe, 360 F.2d 1, 15 (2d Cir. 1966); Huntingdon v. Crowley, 64 Cal. 2d 647, 656, 414 P.2d 382, 390, 51 Cal. Rptr. 254, 262 (1966); People v. Busch, 56 Cal. 2d 868, 878, 366 P.2d 314, 320, 16 Cal. Rptr. 898, 904 (1961); Commonwealth v. Piper, 120 Mass. 185 (1876); State v. Glavkee, 138 N.W.2d 663 (N.D. 1956); State v. Kristich, 226 Ore. 240, 359 P.2d 1106 (1961); State v. White, 60 Wash. 2d 551, 568, 374 P.2d 942, 953 (1962); MCCORMICK § 152, at 319-20; MODEL CODE OF EVIDENCE rule 303 (1942); UNIFORM RULE OF EVIDENCE 45; *cf.* People v. Phillips, 64 Cal. 2d 574, 578 n.1, 414 P.2d 353, 357 n.1, 51 Cal. Rptr. 225, 229 n.1 (1966); State v. Garcia, 413 P.2d 210, 213 (N.M. 1966).

If an expert criminologist-statistician, the optimal testificant of probabilistic data in a criminal trial, or other expert witness, is allowed to compute a statistic only on the evidence already before the court and is deemed incompetent to bring the necessary basic data before the court himself, the parade of witnesses necessary to establish the raw data could result in the exclusion of the evidence. See 6 WIGMORE, EVIDENCE § 1864, at 489-91. It seems unlikely that such a restriction would be placed upon an expert testifying to probabilities, however, for the allowable basis of an expert's opinion has always included not only his own research, but knowledge gained from secondary sources. Cross-examination and rebuttal evidence seem adequate safeguards to protect the opponent against invalid conclusions resulting from unreliable data, for by impeaching the expert's sources his conclusions may be impeached.

a narrowly limited class of cases involving scientific evidence and expert conclusion on the ultimate facts in issue, appellate courts have severely restricted trial court discretion to admit evidence.[61] Expert

[61] Historically, "qualification" of an expert witness and cross-examination were apparently considered sufficient safeguards to protect the courts from unreliable expert testimony. See, *e.g.*, State v. Hinkle, 6 Iowa 380, 386 (1858); Commonwealth v. Spear, 143 Mass. 172, 9 N.E. 632 (1887); Commonwealth v. Sturtivant, 117 Mass. 122, 138 (1875); *cf.* Lindsay v. People, 63 N.Y. 143, 156 (1875); *The Howland Will Case*, 4 AM. L. REV. 625 (1870). The early cases involving expert testimony based upon scientific principles or devices were little more than an extension of the rules permitting demonstrative evidence and expert testimony on matters beyond the general knowledge of the average layman. See, *e.g.*, People v. Jennings, 252 Ill. 534, 96 N.E. 1077 (1911) (first appellate court consideration of fingerprint evidence); Evans v. Commonwealth, 230 Ky. 411, 19 S.W.2d 1091 (1929) (ballistics test); State v. Cerciello, 86 N.J.L. 309, 90 Atl. 1112 (Cr. Err. & App. 1914) (fingerprints). In these cases the jury and the court examined the real evidence, proving to themselves that the conclusions of the expert were correct. The offer of conclusions not subject to this sort of independent confirmation led one court to adopt a new test based upon "general scientific acceptance." Frye v. United States, 293 F. 1013 (D.C. Cir. 1923) (lie detector results). *Compare ibid. with* Laney v. United States, 294 F. 412, 416 (D.C. Cir. 1923) (ballistics evidence, same court, same justice, same day; test not applied). The general acceptance test has since been parrotted through the various jurisdictions as the touchstone for admissibility of scientific evidence. See, *e.g.*, Lindsey v. United States, 237 F.2d 893, 896 (9th Cir. 1956) (sodium-pentothal test); Medley v. United States, 155 F.2d 857, 860 (D.C. Cir. 1946) (spectroscopy); Rivers v. Black, 259 Ala. 528, 531, 68 So. 2d, 24-5 (1953) (dictum) ("drunkometer"); Huntingdon v. Crowley, 64 Cal. 2d 647, 656, 414 P.2d 382, 388, 51 Cal. Rptr. 254, 260 (1966) (blood test); Commonwealth v. Fatalo, 346 Mass. 266, 269, 191 N.E.2d 479, 481 (1963) (polygraph); People v. Morse, 325 Mich. 270, 274, 38 N.W.2d 322, 324 (1949) ("drunkometer"); Beuschel v. Manowitz, 151 Misc. 899, 901, 271 N.Y.S. 277, 280 (Sup. Ct. 1934) (blood grouping test); State v. Bohner, 210 Wis. 651, 657, 246 N.W. 314, 317 (1933) ("lie detector").

McCormick has criticized the use of a simplistic "acceptance" test as determinative of admissibility on the ground that it is unduly restrictive and impedes acceptance of novel but valuable scientific techniques. MCCORMICK § 170, at 363-64. He argues that relevant conclusions advanced by a qualified expert witness should be excluded only on the grounds of unfair surprise, undue consumption of time, or for their misleading effect on the jury. However, except for the structurally created inhibition which results from the reluctance of attorneys and trial judges to risk error by offering and allowing the use of novel evidence, McCormick's criticism seems much ado about nothing; for the test actually applied by the courts in almost every instance has been a modified acceptance test directed at the primary question of relevancy.

An inaccurate or false conclusion or statement is obviously irrelevant when offered to prove a contention. If a scientific process or device frequently produces inaccurate results, then, in a large proportion of the cases employing evidence based upon it, irrelevant evidence will have been accepted. Rather than reviewing each case involving this type of evidence on an *ad hoc* basis, appellate courts have chosen to usurp the trial courts' discretionary function to admit and exclude evidence. By judicial fiat they exclude as inadmissible on the ground of unreliability an entire class of evidence when the aggregate information reaching them indicates that a substantial proportion of the conclusions produced by a particular scientific process or device are inaccurate.

The cases involving "lie detector," "truth serum," and paraffin tests, the former two currently excluded almost universally, clearly illustrate this judicially created exclusionary policy first articulated in Frye v. United States, *supra*. For a number of years the "lie detector" cases following *Frye* adopted the "general scientific acceptance"

testimony based upon polygraph,[62] "truth serum"[63] and paraffin tests[64] has been entirely repudiated by many appellate courts. Blood tests, especially in paternity cases, have been similarly, though less severely, restricted.[65] Such restriction is predicated *jointly* upon a known history of unreliable results and upon the "aura of certainty"[66] attributed by jurors to "scientific evidence."[67]

The seemingly conclusive definity of probabilistic evidence could lead some appellate courts similarly to restrict its use. Even when the testifying expert apprises a jury of the limitations of a probability statistic, its "aura of certainty" may negate the conditional form in which it was advanced, causing the evidence to be given more than

language, though actually imposing a standard of dependability and reliability. See, *e.g.*, Boeche v. State, 151 Neb. 368, 377, 37 N.W.2d 593, 597 (1949); People v. Forte, 167 Misc. 868, 870, 4 N.Y.S.2d 913, 916 (Kings County Ct. 1938); State v. Bohner, *supra*. More recent cases involving "lie detector," "truth serum," and paraffin tests, the only tests which many states exclude entirely, discuss unreliability, quoting extensively from secondary authority to support such a finding, but also include references to the "general scientific acceptance" test. See, *e.g.*, Lindsey v. United States, *supra*; Dugan v. Commonwealth, 333 S.W.2d 755, 757 (Ky. 1960); Commonwealth v. Fatalo, *supra*. With increasing clarity the opinions indicate that inadmissibility rests on the unreliable character of the rejected class of evidence. See, *e.g.*, People v. Carter, 48 Cal. 2d 737, 752, 312 P.2d 665, 674 (1957); Brooke v. People, 139 Colo. 388, 393-94, 339 P.2d 993, 996 (1959). This approach does not, in theory, require that the expert demonstrate to the trial court general acceptance of the process as a prerequisite to admission of his testimony; rather it demands only that the expert demonstrate the reliability of the process. See note 48 *supra* and accompanying text. See also note 67 *infra*.

[62] See, *e.g.*, Nichols v. State, 378 S.W.2d 335, 337 (Tex. Crim. App. 1964) (mere intimation of polygraph results held incurable error requiring mistrial).

[63] See, *e.g.*, Lindsey v. United States, 237 F.2d 893 (9th Cir. 1956) (conviction reversed for prosecution rehabilitation of key witness through psychiatric testimony based on narcoanalysis); State v. White, 60 Wash. 2d 551, 568, 374 P.2d 942, 953 (1962) (trial court's discretion not exceeded in refusing defendant's statements under narcoanalysis).

[64] See, *e.g.*, Brooke v. People, 139 Colo. 388, 393-94, 339 P.2d 993, 996 (1959) (paraffin tests deemed inadmissible).

[65] See, *e.g.*, People v. Nichols, 341 Mich. 311, 67 N.W.2d 230 (1954) (test not establishing non-paternity excluded); State v. Beard, 16 N.J. 50, 106 A.2d 265 (1954) (with proper instruction accused murderer's blood type admissible); Hendricks v. State, 296 P.2d 205, 219 (Okla. Crim. App. 1956) (no error to exclude evidence of defendant's blood type when he was not shown to have bled). See generally Annot., 46 A.L.R.2d 1000 (1956).

[66] Huntingdon v. Crowley, 64 Cal. 2d 647, 656, 414 P.2d 382, 390, 51 Cal. Rptr. 254, 262 (1966).

[67] Care must be taken to distinguish cases affirming a trial court's discretion to exclude evidence, *e.g.*, Huntingdon v. Crowley, 64 Cal. 2d 647, 414 P.2d 382, 51 Cal. Rptr. 254 (1966), from the hard core cases barring the use of particular forms of evidence, *e.g.*, Lindsey v. United States, 237 F.2d 893 (9th Cir. 1956). The former are often couched in terms of the judicial notice "acceptance" test, but, in fact, turn on the absence of abuse of trial court discretion. See, *e.g.*, Huntingdon v. Crowley, *supra*. The latter cases apply a "known unreliability" standard. See note 61 *supra*.

its legitimate probative weight. Blanket appellate exclusive seems to be an inappropriate remedy, however, for the general acceptance of the probabilistic process lends considerable support to its regular reliability.[68] The power of the trial court to exclude for unwarranted prejudicial impact, subject to review, and the requirements of qualification are more appropriate limitations on its use.[69] Assuming these can be surmounted, however, some further safeguards may be desirable.

The drawing of unwarranted inferences from expert testimony has long been thought rectifiable by cross-examination, rebuttal, and countering argument;[70] but evidence of a complex nature, especially where encountered without time for preparation, may limit the effectiveness of these protective rights. Because of the novel and specialized nature of probabilistic evidence, fairness and judicial expediency seem to dictate some advance notice by the proponent to the court and the opposite party of the nature and content of the evidence to be offered.[71] Both opposing counsel and the court

[68] See generally ABSTRACT SERVICE, QUALITY CONTROL AND APPLIED STATISTICS (1967). Occasional unrealiability *in application* of a new process or device has not been sufficient to cause exclusion of evidence based upon it. See, *e.g.*, People v. Roach, 215 N.Y. 592, 605, 109 N.E. 618, 623 (1915) (first New York Court of Appeals case on fingerprint evidence).

[69] Numerous considerations, including the necessity of the evidence to the proponent's case, the strength of the foundation laid, and the remoteness of the evidence to the principal issues of the case bear upon a trial court's decision to admit or exclude evidence for its undesirable prejudicial impact. Consideration is also given to the complexity of the evidence and its tendency to obscure the true issues by the time consumed in presentation and the welter of collateral issues raised. Since a balance of the probative worth of evidence offered against its undesirable effects can only be made in concrete situations, and must include an evaluation of factors impossible to record, as well as what is said, exclusion for prejudicial impact or potentially misleading effect must necessarily be left largely to the discretion of the trial judge. See, *e.g.*, United States v. Bowe, 360 F.2d 1, 15 (2d Cir. 1966); UNIFORM RULE OF EVIDENCE 45, comment.

[70] The primary focus has traditionally been on the expert testifying and not upon the processes he employed. After qualification as an expert, a witness was allowed to state his conclusions. The opponent of the testimony could then diminish their impact through cross-examination, rebuttal evidence, and argument. The credibility of the testimony and weight it was to be given was said to be a matter for the jury's consideration. See, *e.g.*, State v. Hinkle, 6 Iowa 380, 386 (1858); Commonwealth v. Spear, 143 Mass. 172, 9 N.E. 632 (1887); Commonwealth v. Sturtivant, 117 Mass. 122, 138 (1875); Lindsay v. People, 63 N.Y. 143 (1875). *The Howland Will Case*, 4 AM. L. REV. 625 (1870). See also State v. Kozokonis, 214 A.2d 893, 896-97 (R.I. 1965).

[71] The discovery procedures increasingly available to the criminal defendant seem sufficient protection of the accused's rights where he receives notice of the witnesses who will testify against him. It is generally held that the trial court has discretionary power to permit inspection of evidence possessed by the prosecution, *e.g.*, State v. Gilman, 63 Wash. 2d 7, 385 P.2d 369 (1963), and where the evidence is of a specialized or com-

would thereby gain the opportunity to examine the validity of the evidence in the relative calm of the pretrial setting, eliminating delay during trial for a lengthy hearing and for rebuttal preparation time based on a claim of surprise.[72]

The party against whom probabilistic evidence is offered would often need to employ an expert to assist him in analyzing the evidence for the purpose of cross-examination and rebuttal. Therefore, the use of probabilistic evidence against indigent criminal defendants, who comprise a large percentage of those tried for criminal offenses,[73] seems particularly unfair unless the indigent is provided with expert assistance. Some states make provision for appointment of a disinterested expert at government expense in an attempt to lessen the danger that the state will unfairly marshal its resources against indigent defendants.[74] A broader adoption of such a plan is desirable if probability statistics are to be offered as primary evidence for jury consideration.

Also desirable is a cautionary instruction which explains the nature of the evidence offered, puts its probative value in perspective, and appropriately limits the use that can be made of the evidence.

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plex nature, such as probability evidence, fairness to the defendant may require production of the data. See Layman v. State, 355 P.2d 444 (Okla. Crim. App. 1960); note 57 *supra*. *Cf.* Baron Tube Co. v. Transport Ins. Co., 365 F.2d 858 (5th Cir. 1966). Liberal exercise of this discovery power in connection with probabilistic evidence seems desirable.

[72] Under FED. R. CRIM. P. 17.1 the judge has the power to order, or hold at the request of a party, a pre-trial conference. Where such conferences are available, the need to lay an extensive foundation for the introduction of probabilistic evidence at the trial might be eliminated by incorporating data sufficient for review purposes concerning the computation of the offered statistic into the memorandum of the conference prepared by the judge holding the conference. The memorandum could thereafter be appended to the record for appellate review.

[73] As many as sixty per cent of the defendants in criminal actions in state and federal courts are financially unable to obtain counsel, and thus logically an even higher percentage of defendants could not afford the cost of an expert witness' services. See Pye, *The Administration of Criminal Justice*, 66 COLUM. L. REV. 286, 287 (1966).

[74] See, *e.g.*, 18 U.S.C. § 3006A (e) (1964); CAL. EVID. CODE §§ 730-33; ILL. REV. STAT. ch. 38, § 113-3 (e) (1965) (limited to capital cases); N.Y. CODE CRIM. PROC. § 308; WIS. STAT. § 957.27 (1963).

In People v. Watson, 221 N.E.2d 645 (Ill. 1966), the Illinois Supreme Court, on the basis of the sixth and fourteenth amendments to the United States Constitution and a similar provision of the state constitution providing for process to compel the attendance of witnesses, held that an indigent defendant is entitled to expert assistance at state expense when such assistance is required to establish a defense. Commenting on the existing Illinois statute, *supra*, the court urged expansion of the section "to include non-capital cases where expert testimony is deemed by the trial judge to be crucial to a proper defense." 221 N.E.2d at 649.

Such an instruction should outline the inference drawing process, illustrate the application of a probability statistic to that process, and specifically note that the statistic of itself creates *no* inference.[75]

Even when appropriate measures are taken to guard against abuses, there remains a considerable danger of prejudice arising from the use of probabilistic evidence. It appears, therefore, that trial courts *for the present* should exclude such evidence whenever it is not clearly shown to have been validly computed by a statistician skilled in the statistical analysis of data generated by human activity. The multitude of variables present in such data requires numerous assumptions in reducing it to mathematical abstractions. An "expert" aware of and capable of making such assumptions is desirable, for if he values his reputation as an "expert," he will not testify where he is uncertain that the required assumptions can validly be made, and the calculated statistic which he does present will be an opinion worthy of consideration.

In many cases where there are numerous recognizable "traits" associated with the object of testimony a probability statistic relating

[75] An instruction to the jury might take the following form:

"A part of the [prosecution's; defendant's] case consists of mathematical probabilities which purport to estimate the frequency with which [certain specified traits] occur within a group composed of all individuals who could have committed the crime. The statistic is an estimate, stated in mathematical terms, of how common or uncommon [these characteristics] are. The prosecution has attempted to link the accused to the crime by asking you to find that the accused [has these characteristics] which it alleges are possessed by the criminal. The prosecution has asked you, should you find that both the accused and the criminal do have [these characteristics], to infer that the accused and the criminal are one person, that the accused is the criminal.

"Before you may consider the probabilistic evidence you *must* find that both the accused and the criminal have [these characteristics]. If you *do* find this to be so [and if, in spite of the rebuttal evidence presented by opposing counsel, you find the statistic to have been validly computed by a knowledgeable expert in this field], then you may use the statistic to help you weigh the inference of identify which you might be able to draw from the allegedly similarity of trait between the accused and the criminal. [You must remember, however, that *no matter how infrequently* [*the characteristic*] *is estimated to occur* there is still the possibility that another person or persons with [these characteristics] exists, and this other person or one of these other persons—if one considers *no* other evidence than the alleged similarity of trait—could be the criminal. Thus, to convict the accused, you *must* find other evidence which connects the accused to the crime.]

"The statistic, of itself, creates *no* inference. Whether or not an inference should be drawn from evidence given to you remains a matter which requires your human judgment. Only you can determine at what point the probability of the truth or falsity of evidence presented to you is sufficiently great that *you* are willing to accept or to reject that evidence and base a further decision upon your acceptance or rejection."

the accused with the population of interest *would* sharpen the inference drawn;[76] but it must be remembered that the same inference can often be logically deduced from the fact-finder's own experience and the circumstances presented. Further, "the ground work has simply not been adequately covered for explicit statistical or probabilistic results to be used in any but the most elementary of situations, and extreme care must be taken even in these."[77] Thus, unless the accuracy and superiority of a statistical inference are clearly shown, it appears far better that the fact-finder's inference drawn on the basis of his own experience should control, for the potential prejudice in excess of probative value arising from the "aura of certainty"[78] which surrounds the scientific "expert" seems great. As jurors grow increasingly sophisticated in handling "scientific" evidence, however, this danger will tend to abate.

In spite of the potential dangers associated with probabilistic evidence, appellate courts should not adopt the stance taken with respect to "lie detector," "truth serum," and increasingly with paraffin tests and fully exorcise its use, unless indiscriminate employment of such evidence is found to be the norm.[79] The potential uses and value of evidence based on the frequency estimation concept are limited only by the skill of modern statisticians in collecting and analyzing data. To proscribe the use of a form of evidence before it is fully explored would be shortsighted indeed. Rather, the technique employed in *State v. Sneed* would seem more appropriate: decisions involving probabilistic evidence should be made on narrow grounds, upholding or reversing the ruling of a trial court on admissibility strictly within the context of the objections raised.[80]

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[76] See note 38 *supra.*

[77] Letter from Charles R. Kingston, Chief, Criminalistics Research Bureau, Identification and Intelligence System, State of New York to the *Duke Law Journal,* Nov. 3, 1966.

[78] Huntingdon v. Crowley, 64 Cal. 2d 647, 656, 414 P.2d 382, 390, 51 Cal. Rptr. 254, 262 (1966).

[79] See note 61 *supra.*

[80] In People v. Trujillo, 32 Cal. 2d 105, 194 P.2d 681, *cert. denied,* 335 U.S. 887 (1948) (see note 50 *supra*), where the objection raised to probabilistic evidence was "self-incrimination," the court treated only that issue. Failure to pursue an objection and failure to make a timely request for a court appointed expert were the basis for denial of appellant's limited objection to probabilistic evidence in People v. Jordan, 45 Cal. 2d 697, 290 P.2d 484 (1955). A similar failure to raise significant objection is illustrated by Born v. State, 397 P.2d 924 (Okla. Crim. App. 1964), *cert. denied,* 379 U.S. 1000 (1965), where, though the court found that paraffin tests were in general

Such an approach would decrease the likelihood that unfortunate precedent will be set in this fertile field of evidence before the subject is ripe.

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unreliable, the admission of the results of such a test was not prejudicial error where the objection raised was not on the ground of unreliability.