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Evidence - Rules of Admissibility and the Law of Probability

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EVIDENCE — RULES OF ADMISSIBILITY AND THE LAW OF PROBABILITY

I. INTRODUCTION

There has been great confusion, frustration, and bewilderment as to the role that statistical mathematics ought to play or does play in the concept of legal proof.[1] As the science of probability has become more influential in the world of the social scientist, the resistance to its application at the bar has become even more confirmed. Unfortunately, many of the so-called arguments against the use of this science are based upon fear and ignorance, being couched in verbiage that reeks of ad hominem fallacy and begs the question.

The problem would be more easily dismissed if the legal system itself did not define terms of proof in language that is definitely predicated upon concepts of mathematical probability. The quantum of evidence required in civil cases is a preponderance which is defined as more probable than not.[2] When approached from a coldly problematical standpoint, the legal system immediately refuses to honor its own formula and dismisses the dilemma with a wise word that such mathematical trivium invades the jury's function or that the concept would confuse a lay jury.[3]

All of this philosophy would be academic if it were not for the defendant, whose legal rights hang on the outcome of such a debate. Underlying the dilemma that the legal profession finds itself cast upon is an idea of substantial justice. For, if the law demands more or less from an inference than is mathematically possible, then the legal discipline is fabricating arbitrary rules that cannot possibly determine the true predictability of certain events. As a result, the verdict is predicated not upon what occurred, but what the law arbitrarily demanded.

1. McCORMICK, EVIDENCE § 171 (1954).
2. *Id.* at § 319.
3. *See* Ball, *The Moment of Truth: Probability Theory and Standards of Proof*, 14 VAND. L. REV. 807 (1961).

Fortunately, the divergence between these disciplines seems to be more semantic and problematic than philosophic. To understand the problems involved, one must first endeavor to become familiar with the basic premise upon which probability is founded, and then apply these techniques to legal proof.

II. PROBABILITY—SOME CONCEPTS

The legal mind has to overcome more than a fear of math to fully grasp the concepts of probability. The terms and phrases of this discipline relate to definite determined relationships. The courts and many legal writings tend to commingle these mathematical terms in a synonymic fashion. Doing this confuses the argument and from a logical standpoint is fatal.[4] Statistics, for instance, is a generic term covering many facets of inductive inference, while probability is a specific term having a definite relationship which uniquely specifies a mathematical relationship.

A statistical hypothesis is an assumption about the probability model of a random variable; and the test of this hypothesis is a means for accepting or rejecting it.[5] In essence, statistical testing is a process for making inductive inferences from observed data. This process can become highly complicated and technical. This technique is not a concept which has application in the court room, because the legal inferences lie within the probability model itself, and not within the methods for making inferences about factual events. The inference to be drawn from a probability model is a jury function.

Probability and probability models, unlike statistical hypotheses, are measures of likelihood and may be expressed in percentage terms.[6] At the outset, the lawyer must realize two important principles of probability: the first being that probability is not some mystical approximation of chance but a mathematical relationship rigidly defined.[7] The other is

4. Since this discipline is, by its nature, axiomatic, the language is specific in terms of mathematical relationships.

5. HOEL, INTRODUCTION TO MATHEMATICAL STATISTICS 46 (3d ed. 1962).

6. GUENTHER, CONCEPTS OF STATISTICAL INFERENCE 3-6 (1965).

7. *Id.*

that probability never predicts the single event, *i.e.* there is no certainty. Probability only relates to the likelihood of an outcome. If some event has a one-in-a-million chance of happening, there is still that one chance.

One stumbling block to the understanding of probability seems to be that there are two distinct definitions. The classical, or a priori, definition is predicated on having n, equally likely, mutually exclusive events of which f is the number of favorable outcomes. The probability of a favorable outcome is then f/n. This gives a ratio with an upper limit of 1 and a lower limit of 0. Using this definition, one may incorrectly assume that a coin biased towards coming up heads has a probability of 1/2 of landing on the heads side. In this example, there are two mutually exclusive events, one of which is favorable;[8] but they are not equally likely. One can see this definition can lead to erroneous results. The probability that the coin will land heads is more likely than the event that it does not. The second definition takes this into account.

The second definition of probability is referred to as the relative frequency definition. If an experiment is performed many times (n) and f of these experiments are favorable, then the probability of a favorable event is assumed to be equal to f/n.[9] In the biased coin example, if every one of the previous n trials has resulted in a favorable outcome—a head —then the quantity f/n will be equal to one. But the probability that a coin will land heads is one, only if the coin is doubleheaded.[10]

This second definition is the one that is used whenever the data is available. The first may only be used when the n events are equally likely, such as the flip of a fair coin or the role of fair dice. While this distinction may sound superfluous, a misuse of these definitions can lead to incorrect results. A legal example of this problem is illustrated when the prosecution seeks to show that its exhibit A, a gun, was the

8. *Id.*
9. *Id.*
10. In reality, the probability can never approach certainty, or one. Even if f is equal to n, there is always some small probability that the coin is not a double headed coin.

murder weapon. The expert testifies that the gun that killed the victim had a right-hand rifling. Since any gun could have either a right-hand or a left-hand rifling, using the classical definition and assuming that a weapon picked at random is equally likely to have a right-hand or a left-hand rifling, the probability that a randomly selected gun could be the weapon is 1/2. A sample of guns or a report from manufacturers would show this to be an erroneous assumption, since almost all the guns in the world have right-hand riflings and only a small percentage have left-hand riflings. An accurate determination of the probability would be the percentage of all the guns manufactured that have left-hand riflings. Therefore, the probability that any random gun had right-hand riflings is extremely high, not 1/2.

For the most part, the jury can get an intuitive feel for the probability associated with simple examples like throwing a biased coin or a fair die. But, when a series of these single probabilities is put together, then intuition fails. The most important concept in this context is the relation of one event to another. These relationships are of three types: mutually exclusive, independent, and dependent.

Two events are mutually exclusive when the happening of one absolutely precludes the happening of the other.[11] For instance, the probability that a person could get a two *and* a three on a single throw of a single die is zero. This concept is unknowingly used in legal proof described as alibi.[12] If a murder took place at tavern A at 9:00 p.m. on October 2, 1971, the defense may show that no one in bar A saw defendant. This is not conclusive, since all it proves is that no one saw the defendant. However, if the defense introduces evidence that many people did see the defendant in another bar, say B, at exactly the moment the murder took place, then the proof is conclusive. The reasoning is predicated on the concept of mutually exclusive events. It is impossible that the defendant could have been present in bar A and bar B at exactly the same instant.

11. HOEL, *supra* note 5, at 7.
12. *See* MCCORMICK, *supra* note 1, § 321.

Two events are independent of one another if the happening of one event in no way affects the happening of the second.[13] In two flips of a coin, the probability that the second flip is a head is in no way affected by the outcome of the first toss. Another way of saying this is that the outcome of the second event "does not care" or is in no way predicated upon the outcome of the first. The probability of the second flip of a fair coin is going to be 1/2, no matter the result of the first flip. When two events are independent, the order of their happening has no affect on the probability. The probability of getting two heads is the same whether the coin is flipped twice or two coins are flipped at the same time.

Two events are dependent when the outcome of one event affects the probability of the outcome of the second.[14] If there are three white and two black balls in a bag, the probability of drawing a white ball on the *second* of two successive draws, *without replacement,* depends on the outcome of the first draw. If a black ball is drawn first, then the probability that a white ball is drawn on the second draw is 3/4. There are only four balls left when the second draw commences and three of them are white. However, if the first draw was a white ball, the probability of getting a white ball on the second draw is only 2/4 or 1/2. Again, there are four balls left, but now only two of the remaining are white.

The concept of dependency may also be expressed as the probability of event A given that B has occurred. In the above example, the probability of getting a white ball on the second draw (event A) depended upon the color of the first drawn ball (event B). Once event B was determined, the probability of event A could be determined. Event A was "conditioned" upon the outcome of B.

The concept of relevancy in legal proof is based upon the concept of the dependent event. Since relevancy is probative worth and not really a rule of evidence, it establishes a "connection" or "relationship" between event A and event B.[15]

13. HOEL, *supra* note 5, at 7.
14. *Id.*
15. MCCORMICK, *supra* note 1, § 151.

Contrawise "irrelevant material" establishes no probative relationship between event A and event B. That is, event A and event B are independent; the happening of one in no way affects the outcome of the other. Unfortunately, to add to the confusion, law has adopted the term relevancy for determining admissibility of other evidence that cannot be measured in terms of dependent and independent events. Some writers call this type of relevance "legal relevancy,"[16] as distinguished from "logical relevancy." Instead of having a logical basis, the rules are predicated on policy.

III. THE CONJUNCTIVE AND DISJUNCTIVE CONSTRUCT

The preceding discussion, definitions, and examples are the heart of the logical concept of discrete events that may be described in terms of a mathematical model. Unfortunately, real-life situations and especially fact situations in a law suit rarely present themselves in the simplistic guise of the flip of a coin or the roll of a die. When a witness testifies that she saw A in tavern B, she is relating a large number of pieces of information. She matches eye color, skin tone, height, weight, etc. of the man she saw and the man A.

In probability theory there must also be a way to relate a set of events, each of which has a probability which is determined by the f/n formula. The devices used for this are called the multiplication and addition theorems. The former is predicated on the logical "and" or the conjunctive, the latter upon the logical "or" or disjunctive. The result obtained is dependent upon the types of events that are "multiplied" or "added" together.[17]

The "multiplication" theorem allows one to calculate the probability that many events occur together. What is the probability that event 1 *and* event 2 occur? The answer gives the probability that both occur or the logical conjunctive. While this concept seems simple enough, the problem lies in the types of events that are to be "multiplied." If the events

16. *See* James, *Relevancy, Probability, and the Law*, 29 CALIF. L. REV. 689 (1941); Cowan, *Decision Theory in Law, Science, and Technology*, 17 RUTGERS L. REV. 499, 502-05 (1963).
17. HOEL, *supra* note 5, at 8-12.

are *mutually exclusive,* then the probability that event 1 and event 2 occur at the same time is zero. For example, if one were to try to determine the probability that a man was white (event 1) and also a Negro (event 2), the probability is zero. He can't be both white and Negro at the same time. If, however, the two events are independent, and not mutually exclusive, the probabilities are algebraically multiplied together.[18] For instance, to determine the probability of getting two heads in two tosses of a coin, the probability of getting one head (1/2) is multiplied times the probability of getting a second head (since they are independent, the probability is also 1/2) and the answer is 1/4. The last possibility is that the two events are dependent. The probability that event 1 and event 2 occur together is the probability that event 1 occurs times the probability that event 2 occurs given event 1 has occurred. Going back to the example of the balls in a bag, and drawing without replacement, the probability that a white and then a black ball is drawn is equal to the probability that a white is drawn on the first draw (3/5) times the probability a black is drawn on the second, *given* a white was drawn on the first (1/2).[19]

The "addition law" is similar in application except that the question becomes the logical disjunctive. What is the probability that even 1 *or* event 2 occur? For example, in the mutually exclusive case of the die, the probability that a two *or* a three is rolled equals the probability a two is rolled (1/6) plus the probability a three is rolled (1/6). The probability is then 1/3. Derivation of the independent and dependent cases is similar.[20]

18. *Id.*
19. *Id.*
20.

	Mutually Exclusive	Independent	Dependent
Mult	$= 0$	$P(E_1)\ P(E_2)$	$P\ (E_1)\ P(E_2/E_1)$
Add	$= Pr(E_1)+Pr(E_2)-P(E_1E_2)$	$P(E_1)+P(E_2)-P(E_1E_2)$	$P(E_1)+P(E_2)-P(E_1E_2)$

Where: $Pr(E_1)$ = Probability of Event 1
$Pr(E_2)$ = Probability of Event 2
$Pr(E_2/E_1)$ = Probability that E_2 occurs given that E_1 has already occurred.
$Pr(E_1E_2)$ = Probability that E_1 and E_2 occur together

In the legal setting, this ability to "cumulate" ascertainable events is invaluable. Going back to the murder weapon example, if one assumes for argument that the probability of right-hand versus left-hand turns on a pistol is 1/2 and the probability that it is a revolver is 1/2 and that it"shaves" the bullet on the right is 1/2, then the probability that any random gun has these *independent* characteristics is (1/2) (1/2) (1/2) or 1/8. If exhibit A has these characteristics, then the probability that the exhibited gun is, in fact, the murder weapon becomes more certain, that is the exhibited weapon is not any random gun. The more significant independent events that the exhibit A and the murder weapon have in common, the "more likely" that exhibit A and the theoretical gun that killed the victim are the same gun. At some point, a reasonable man would say that they are the same gun.[21]

IV. NATURE AND THE LAW OF PROBABILITY

One last concept need be explored prior to applying these concepts to the field of legal proof. Thus far, the mathematical models discussed are predicated upon the randomness of the law of nature.[22] The uncertainty of the event is known within the model, and is dependent solely upon the way nature operates on an object in the state of nature. This concept is randomness under uncertainty and gives credence to the models.[23]

If one were to flip a coin one thousand times in succession recording the favorable responses such that it resulted in a determination of f/n, then the probability that this coin gives favorable response is assumed to be f/n. The repetitiveness of the experiment is a requisite to making the probability models thus far discussed meaningful. Factors such as temperature, lighting, how the coin feels today, have little or no relevance to the probability of the coin turning up heads.

21. Statisticians draw inferences under uncertainty by determining the error under the distribution. They are called Type 1 and Type 2 errors. *See* HOEL, *supra* note 5, at 48-61.

22. CHERNOFF & MOSES, ELEMENTARY DECISION THEORY §§ 1-4, at 1-12 (1959).

23. PARZEN, MODERN PROBABILITY THEORY AND ITS APPLICATIONS 5-8 (1960).

With man, however, the relationship of factors to his performance becomes obscured, and using the simple models discussed here becomes hazardous. Human behavior lacks the repetitiveness that the coin example has. Man's memory and interpretation of the conditions may make him react in a way that is not consistent with past observations.

Sociologists, psychologists, and economists have been plagued by this fact since they began to study human behavior. Concepts such as the "economic man" have been introduced to try to alleviate the inherent problems.[24] But, the uncertainty under these assumptions renders the simple models presented here subject to large error.

Some legal examples may help to make this concept more clear. If A is indicted for murder and the prosecution shows that A had committed five other murders, is the evidence of the five other murders logically relevant? The answer is uncertain. Everyone would believe that if a person murdered five other people, the probability that he would murder a sixth is greater than if he had previously murdered no one. But because each murder is under different circumstances which A interprets and reacts to differently, the simple f/n models cannot give relevant information to a jury. Contrast this to the gun example given previously. If a bullet from exhibit A (the weapon) showed the firearm to have right-hand rifling, etc. then the next bullet will show the same. In dealing with human behavior, the experiment lacks this "repetitiveness" under nature. In the coin or bullet examples, one can essentially ignore the errors that occur in the state of nature because they are negligible. A gun does not react differently if it is pointed at A rather than B. With human nature, one cannot get this unbiasedness, and the error becomes so large as to obviate the models.[25]

In one case[26] the court allowed evidence of a similar offer to contract between defendant and another party to be admitted to *prove the substance* of an oral contract between

24. CHRIST, ECONOMETRIC MODELS AND METHODS §§ 1-5, at 1-14 (1966).
25. There exists a whole discipline which concerns itself with human behavioral decision making. *See* CHERNOFF & MOSES, *supra* note 22.
26. Firlotte v. Jesse, 76 Cal. App. 2d 207, 172 P.2d 710 (1946).

plaintiff and defendant. The Court of Appeals, in upholding the admission of such evidence, contended that a logical inference could be drawn between the previous offers by defendant to another party and the contract in issue.[27] That is, the proving of event A (subsequent offer to third party) said something mathematically about the probability of event B (contract between plaintiff and defendant). As was seen previously, this is a statement of conditional probability. What is probability of event B, given event A has happened? Since the act of making a contract is subject to all the conditions upon which the contract is based including the feelings of the parties and their relative bargaining powers, a contract made with A and one made with B are for all practical purposes independent events. The mere happening of the first says nothing determinative about the probability of the second. This makes the prior offer logically irrelevant. Unfortunately, Wigmore seems to be in accord with this holding, contending that such evidence is relevant when circumstances in one situation indicate a *strong probability* that the contract in one instance is the contract in another.[28] The law makes the defendant pay based upon a presupposition that cannot be determined by probability.

V. CIRCUMSTANTIAL EVIDENCE AND PROBABILITY

The legal discipline generally accepts the proposition that evidence is of two basic types. The first is designated "direct" and proves the fact in issue.[29] There is no need for logical inferences in this type of evidence, because the sole question to be "legally" determined is its worthiness of belief.[30] If a witness says, "I saw the defendant shoot the victim," then the only determination to be made is the veracity of the witness's statement. If he is telling the truth, then the inference under probability is the trivial case of conditional probability. What is the probability of getting a white ball on the *second* draw given that a white ball was drawn on the

27. *Id.* at 208, 172 P.2d at 711.
28. WIGMORE, EVIDENCE § 377 (3d ed. 1940).
29. MCCORMICK, *supra* note 1, § 152.
30. *Id.*

second draw? The answer, of course, is one (certainty), if and only if the observer is telling the truth.

The determination by the jury that a witness is telling the truth is also outside the mathematical models presented, since "telling the truth" is human behavior and subject to all the restrictions discussed in the previous section.[31] Introduction of evidence that the witness never told the truth is of dubious value in determining if he is telling the truth in this case.[32]

The question of logical relevancy is more meaningful in the second type of evidence.[33] Circumstantial evidence gives rise to two determinations. The first is concerned with whether the event sought to be shown actually happened. Again, this has to do with the veracity of the witness. The second is predicated upon whether the event shown by the witness is logically relevant or probative of the fact sought to be "proved." The concepts of probability that have thus far been discussed go only to the second question.

Unless the first question is answered in the affirmative, i.e. that event A happened, then any further attempt to show logical relevancy between event A and event B is futile. The probability model for conditional probability is explicit. The probability of event B (drawing a white ball on the second draw) is only meaningful given event A (the result on the first draw). If the fact that event A happened is disbelieved, then it is as if it did not happen and event B is no greater or less probable than prior to the introduction of the evidence.

This dichotomy has a drawback that may be overlooked. When a witness says, "I saw A kill the victim," then this is direct evidence. But, if she says, "I saw a man with blue eyes, brown hair, etc.," the evidence becomes circumstantial. The distinction between these two types of evidence is not always clear. It is difficult to objectively determine how many independent factors must be present before the evi-

31. This statement is not intended to draw fire from the psychologists. No philosophic argument about the ability of the pathologic liar to tell the truth is intended. The statement is predicated solely upon logic.
32. CHERNOFF & MOSES, *supra* note 22.
33. MCCORMICK, *supra* note 1, § 152.

dence becomes direct, since all a direct witness does is make the determniation from the independent factors. Once the evidence is determined to be circumstantial, then the same problem discussed earlier in the gun example presents itself. How many similar factors must be present between the defendant and the man the witness saw, before there exists a legally sufficient quantum of evidence such that the jury may determine that the man the witness described and the defendant are one in the same?

VI. PROBABILITY—MISAPPLICATION AT LAW

In 1968, the Supreme Court of California heard *People v. Collins.*[34] This case directly raised the question of whether evidence of mathematical probability introduced by the prosecutor to identify the defendants had been properly presented. A woman was mugged and could not identify the assailant or her accomplice; a witness saw a blond ponytailed girl run out of the alley where the crime had taken place, get into a partly yellow car driven by a bearded, mustached Negro and speed away.

The prosecutor proceeded to call a college mathematician as an expert witness to determine the mathematical likelihood that any couple could possess six particular characteristics. These characteristics were: (1) a blond woman; (2) a woman with a ponytail; (3) partly yellow automobile; (4) man with mustache; (5) Negro man with a beard; (6) an interracial couple in a car. The jury convicted the defendants of second degree robbery.

In reversing the conviction, the California Supreme Court, after making the usual argument that such evidence invaded the jury's province,[35] proceeded to explore the approach used to determine the likelihood estimator introduced by the prosecution. The court made it clear that the holding in no way negated the use of probability theory in evidence, but instead found fault with the particular method used.[36]

34. 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968).
35. *Id.*
36. *Id.*

Using the background previously laid in this paper, both the prosecution's original methods and the court's admonition of those methods may be analyzed. First, to make the process easier, one must realize that the evidence is circumstantial because no identifying witness could be found.[37] The problem then becomes akin to the gun example.[38]

The prosecution assigned probabilities (f/n) to the six characteristics. Then assuming their independence, the prosecution proceeded to use the multiplication rule[39] to determine the probability that any couple, picked at random, would have all six characteristics. The number derived was one in 12 million.

A. Probability Determination of Each Character

The determination of the probability that a single factor will occur is equal to f/n, and may be determined by the a priori or relative frequency method.[40] An a priori determination is impossible since the total population is unknown, but the relative frequency definition is plausible. The prosecution, however, guessed at the relative frequencies and the court cited the rule that such odds are inadmissible when not based upon demonstrated data.[41] This criticism is well founded, since failure to correctly assign the probability function leads to fatal analytical error.

Aside from the obvious mistake of failing to substantiate the likelihood function, other more subtle errors existed with the prosecution's case. Likelihood functions exist only for events subject to the state of nature. Therefore, any characteristic that is subject to human decision may not be relied upon to produce dependable results. The characteristics of an inter-racial couple is only viable if some static attribute may be attached thereto. The prosecution assigned this characteristic a probability of 1 in 1,000. These figures were evidently predicated upon the assumption that the couple seen

37. *Id.* at 38, 66 Cal. Rptr. at 502.
38. *See* Section V *supra.*
39. *See* Section III *supra.*
40. *See* Section II *supra.*
41. State v. Snead, 76 N.M. 349, 414 P.2d 858 (1966).

by the witness were, in fact, married. Such an assumption could not be shown true by the evidence presented; and without such proof, the association becomes purely arbitrary.[42]

The characteristic of a ponytail suffers a like fallacy. A hairdo is subject to the whims of the wearer and is not static under the laws of nature. Any attempt to determine the probability that any given person is wearing a ponytail would have to be based upon a survey taken the hour of the robbery, plus a showing that defendant actually wore her hair that way on the day of the crime. Any attempt to prove that defendant always wore a ponytail is of no consequence. That mode of dress is voluntary and even a showing that she never wore her hair any other way is not determinative.[43]

The same criticism may be leveled at each of the characteristics introduced by the prosecution. A blond may dye her hair, a man can shave a beard or conversely wear a false one, and a car can be painted. The court recognized the fallacy by pointing to the ease of disguise. The problem with the court's analysis is that it proceeded to beg the question by demanding more of probability than is demanded of a testifying witness. The court's argument is that no *formula* may prove *beyond a reasonable doubt* that the *witness* correctly described characteristics possessed by the couple who *actually* committed the crime.[44] Admittedly, the criticism is valid, but the fact remains that no court of law may be sure that a witness saw what he thinks he saw. Even eye-witnesses to a crime may be deceived by disguises and point out the wrong man. The jury determines the truth of the statement, whether probability is used or not.[45]

The real criticism of misidentifying characteristics when using probability theory, lies in the innuendo drawn from the likelihood function itself. Since the probability function is predicated on favorable results found in a population, a mistake as to what constitutes a favorable result (f) is fatal. For example, if the probability that one is a blond is 3/4, then

42. *See* Section IV *supra.*
43. *Id.*
44. *Supra* note 34 at 40, 66 Cal. Rptr. at 504.
45. *See* Section V, *supra.*

three out four people over a large sample will be blond. The probability of any given person being a blond is 3/4. If the culprit is a blond, then this eliminates one out of every four people as the possible criminal. But, if the culprit, in reality, is not a blond, the ratio 3/4 is erroneous.

The court finds further fault in that the frequency function is not based upon sound evidence that the population included possible criminals.[46] The argument, simply stated, finds fault with the likelihood function because the population (n) says nothing about who should be included. If n includes all people in California, then there is nothing to show that all people in California are culprits or suspects. This argument assumes that probability theory, in order to be valid, must assume a population of potential criminals, *i.e.* people with criminal intent or motive. The assumption is not true. The only requirement is that there be a possibility that the witness saw someone from the population (n). Whether it could have been a grocer or an ex con is of no import. The only hypothesis that a frequency function is predicated upon is that a particular characteristic be present within the population. The hypothesis is valid for any sufficiently large n, as long as f is a subset of n.[47]

B. Use of the Multiplication Theorem

Once the likelihood functions (f/n) were determined for each characteristic, the prosecution proceeded to multiply the functions together. This resulted in the probability of one in 12 million that all characteristics occur together in a random couple. In order for this method to be valid, each characteristic must be independent.[48]

The court expressed its doubts as to this fact by pointing out the fallacy in assuming a beard and a mustache are independent characteristics.[49] This is a valid criticism of the characteristics presented since it could be shown that having a beard is related to having a mustache.

46. *Supra* note 34 at 38, 66 Cal. Rptr. at 502.
47. FREUND, MATHEMATICAL STATISTICS 7-15 (1962).
48. *See* Section II, *supra*.
49. *Supra* note 34 at 39, 66 Cal. Rptr. at 503.

The court seems to go one step further and negate any attempt to use probability theory, since one can never be sure whether events are in fact independent.[50] This, of course, is not the case. There is a whole body of statistical theory called correlation and regression, which concerns itself with this exact problem.[51]

C. Application of the Discipline

Although the criticisms of the data manipulation in the incident case were sufficient for reversal, the court went further in negating the use of probability theory as applied to legal proof.[52] In so doing, the court exposed some the traditional misunderstandings of principles discussed earlier.[53]

The first glaring error the court made pertains to the maxim that probability does not predict the single event. The error the court found was that the probability figure did not shed any light upon the issue of the defendants' guilt, because it did not prove that, of the few couples with those characteristics, defendants were guilty. This is clearly a fallacious criticism of the discipline. The court would ask of probability what it cannot ask of any circumstantial evidence, *i.e.* certainty. The only fact that was sought to be proved by introduction of such evidence is the likelihood that any random couple would possess the characteristics of the true guilty parties. In no way did the evidence establish that they were the guilty ones. Circumstantial evidence can never do this.

The second criticism of the method is akin to the first, but varies in degree. The court preceeded, upon its own, to show that the probability that there existed at least one other couple with these specific traits was about 40%.[54] Admitting prosecution's figure of one in 12 million, the court calculated, by use of a Poisson approximation of the binomial theorem,[55] that given 12 million random couples, the probability that

50. *Id.*
51. HOEL, *supra* note 5, at 160.
52. *Supra* note 34 at 39-40, 66 Cal. Rptr. at 503-04.
53. *See* Section II, *supra*.
54. *Supra* note 34 at 42-43, 66 Cal. Rptr. at 506-07.
55. GUENTHER, *supra* note 6. at 37-42.

there existed another couple with exactly the same traits as the defendants was about 40%.

To the statistically unadroit, this sounds like a phenomenal number, but in fact, it proves the prosecution's case. What this number means is that if 12 million couples were randomly sampled, the chances of finding two couples with the same characteristics are only 40%. In other words, there is only a 40% chance that a second so designated couple even exists! This is a staggering number out of 12 million couples. To put this number in perspective, a probability of one in twelve million would be like getting 23 heads in a row on 23 tosses of a fair coin. When an eye witness takes the stand and absolutely identifies a defendant as the guilty party, the probability that he is one of a set of identical twins is 1 in 500 or 2,400 times as great![56] Therefore, given that defendant has the characteristics of being one of a set of identical twins, then the probability that in twelve million people there is another with this characteristic is almost one.[57] Further, this makes the probability that the witness saw the defendant's twin or that the defendant is the wrong man equal to 1/2.

VII. CONCLUSIONS

There are two inherent difficulties in applying mathematical probability to circumstantial evidence. The first lies in the fact that it is a mathematical concept which, despite its simplicity, appears to courts as an esoteric and mystical invasion of traditional legal functions. As a result, many of the well-founded legal arguments against use of these methods continuously beg the question. The legal profession incessantly refuses to acquaint itself with even the simplest of maxims. This leads to a total rejection of probability as a fact-finding tool, without a fair evaluation on the merits.

The second difficulty occurs because of the inability of the legal profession to lay an adequate foundation for mathe-

56. *See* Reid, *Does Inheritance Matter in Disease? The Use of Twin Studies in Medical Research,* STATISTICS: A GUIDE TO THE UNKNOWN (Tanur ed. 1972).

57. This number is based upon the Poisson approximation for the binomial using a sample size of 12 million which is $1\text{-}2e^{-1}/1\text{-}e^{-1}$.

matical determination of the factual situations. Many of the criticisms leveled at the theory are, in fact, inherent fallacies in assumption about the data. These errors will never surface, unless the theory is understood. Faulting a discipline as inconsistent, when the assumptions under the theorems are wrong, is hardly a valid criticism.

A possible solution would be to employ a set of statistically significant presumptions which are legally raised when a certain number of independent factors are proved. This is now done with evidence such as finger printing and blood samples.[58] Once the presumption has been raised, then only a showing that the fact presumed (fingerprint identity) is not applicable to the case before the court will negate the presumption. This can be done by showing that of those identical prints that could exist in the world, the defendant's are not the set in question. Defendant may have lost his fingers prior to the crime or set up defense of alibi conclusively proving that the set of prints are not his if the alibi is believed by the jury.

Another possibility is to give the court its own statistical witness who has been admitted to some standard organization and is versed in some aspects of the law. Both sides would be able to cross-examine, as they can any other witness. His job would be to advise the judge of the probability models to be used so that they could be given to the jury by way of instruction. Then, the jury could draw their own inferences from the data. As long as traditional concepts of due process are not abridged, this system is workable.

No matter the procedure adopted, the author feels that continually ignoring the problem is ludicrous. The jury is overtaxed by being forced to determine both the veracity of a witness and the probability that given event A, event B will occur. The only help the law affords is nebulous terms such as "more likely than not," or "a preponderance of the evidence."

58. *See* Note, *Evidence: Scientific Devices: Use of the Chemical Tests for Determining Intoxication*, 1 U.C.L.A. L. REV. 610 (1954).

In the *Collins*[59] case previously discussed, one finds the proposition that a jury could determine the probability of the couple's guilt a little far fetched. If the prosecution had been correct in the assertion that the probability that any random couple would have similar characteristics was one in 12 million, then leaving such a number to be determined by the jury is ridiculous. Once given the probabilities under the appropriate model, the inferences to be drawn, as well as the belief of the witnesses, becomes much easier.

One must ultimately think of a defendant whose freedom rides on a jury bombarded with complex innuendos and logical constructs that even the courts, to date, have not been able to straighten out.

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59. People v. Collins, 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968).