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**THE PEOPLE, Plaintiff and Respondent, v. MALCOLM RICARDO COLLINS,  
Defendant and Appellant****Crim. No. 11176****Supreme Court of California****68 Cal. 2d 319; 438 P.2d 33; 66 Cal. Rptr. 497; 1968 Cal. LEXIS 167; 36 A.L.R.3d  
1176****March 11, 1968**

**PRIOR HISTORY:** APPEAL from a judgment of the Superior Court of Los Angeles County. Maurice C. Sparling, Judge.

Prosecution for robbery.

**DISPOSITION:** Reversed. Judgment of conviction of second degree robbery reversed.

**CASE SUMMARY:**

**PROCEDURAL POSTURE:** Criminal defendant appealed his conviction in the Superior Court of Los Angeles County (California) for second degree robbery in violation of Cal. Penal Code §§ 211, 211(a), and 1157, claiming that reversible error was committed through the use of mathematical theory as evidence in his trial.

**OVERVIEW:** Defendant and his wife were charged with and convicted of second degree robbery in violation of Cal. Penal Code §§ 211, 211(a), 1157. During trial, in an apparent attempt to bolster identification, plaintiff government called an instructor of mathematics as an expert witness and sought, through him, to establish that there was an overwhelming probability that the crime was committed by any couple answering the distinctive characteristics of the defendant and his wife. The witness testified, in substance, to the "product rule," stating that the probability of the joint occurrence of a number of mutually independent events was equal to the product of the individual probabilities that each of the events would occur. Defendant successfully argued that, because trial by mathematics was irrelevant, immaterial, an invasion of the province of the jury, and based on unfounded assumptions so confusing to the jury and defense counsel, its use constituted reversible error.

**OUTCOME:** The court reversed the judgment of conviction and held that defendant's trial by mathematics so distorted the role of the jury and so disadvantaged counsel for the defense as to constitute in itself a miscarriage of justice that mandated reversal.

**CORE TERMS:** probability, couple, prosecutor, robbery, yellow, mathematical, beard, juror, ponytail, random, distinctive, girl, statistical, mathematics, statistics, guilt, blonde, hair, occurring, scene, conversation, mathematical probability, mustache, alley, defense counsel, estimate, mutually, wearing, dark, reasonable doubt

**LexisNexis(R) Headnotes**

***Evidence > Procedural Considerations > Circumstantial & Direct Evidence***

[HN1] Introduction and use of the "product rule" in mathematical probability statistics by the state in a criminal trial injects two fundamental prejudicial errors into a case: (1) The testimony itself lacks an adequate foundation both in evidence and in statistical theory; and (2) the testimony and the manner in which the prosecution uses it may distract the jury from its proper and requisite function of weighing the evidence on the issue of guilt, and encourage the jurors to rely upon an engaging but logically irrelevant expert demonstration, foreclosed the possibility of an effective defense by an attorney apparently unschooled in mathematical refinements, and place the jurors and defense counsel at a disadvantage in sifting relevant fact from inapplicable theory.

***Evidence > Procedural Considerations > Circumstantial & Direct Evidence***

[HN2] Mathematical odds are not admissible as evidence to identify a defendant in a criminal proceeding so long as the odds are based on estimates, where the validity of which has not been demonstrated.

***Evidence > Procedural Considerations > Circumstantial & Direct Evidence***

[HN3] Where an inadequate evidentiary foundation and the inadequate proof of statistical independence exist in the presentation of the "product rule" testimony, any conclusions based on that testimony can only lead to wild conjecture without demonstrated relevancy to the issues presented.

***Evidence > Procedural Considerations > Circumstantial & Direct Evidence***

[HN4] No mathematical equation can prove beyond a reasonable doubt (1) that an accused in fact possesses the characteristics described by the witnesses, or even (2) that only one person possessing those distinctive characteristics could be found in a specific area.

***Evidence > Procedural Considerations > Circumstantial & Direct Evidence***

[HN5] The use of mathematical probability theories in trial must be critically examined in view of the substantial unfairness to a defendant which may result from ill conceived techniques with which the trier of fact is not technically equipped to cope.

**HEADNOTES CALIFORNIA OFFICIAL REPORTS HEADNOTES****(1a) (1b) (1c) Criminal Law--Appeal--Reversible Error--Argument of Prosecuting Attorney--Probability of Guilt--Trial by Mathematics.**

--In a criminal case, it was prejudicial error to allow the prosecution to offer, through an expert, a formula in statistical probability, logically irrelevant and evidentially inadequate, from which the jurors were invited to infer that the odds against defendants' innocence were one in 12,000,000, where the circumstantial nature of the evidence and length of the jury deliberation showed that the case was a close one, and where, under the circumstances, the "trial by mathematics," with which the jurors were not technically equipped to cope, so distorted their role and so disadvantaged defense counsel as to constitute in itself a miscarriage of justice.

**(2a) (2b) Id.--Evidence--Admissions--Admissibility--Retrials: Confessions.** --Upon the post-Miranda retrial of a criminal prosecution, following a reversal based on improper argument to the jury, the original case having been tried in November 1964 (after *Escobedo* and after the *Dorado* rehearing was granted, but before the second *Dorado* decision), the admissibility of any extrajudicial statements sought to be introduced by the prosecution, including those made by defendants to the police both before and after the effective date of *Escobedo* (June 22, 1964), must be determined in the light of *Miranda* rules.

**(3a) (3b) (3c) Id.--Evidence--Degree of Proof--Mathematical Formulae: Argument of Counsel--Province of Jury.**

--The prosecution's misuse of mathematical probability statistics was prejudicial where the testimony lacked an adequate foundation in evidence and in statistical theory, where it was used to distract the jury and encourage them to rely on a logically irrelevant expert demonstration, where it foreclosed the possibility of an effective defense by an attorney unschooled in mathematical refinements, and where it placed the jurors and defense counsel at a disadvantage in sifting relevant fact from inapplicable theory.

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**(4) Id.--Evidence--Degree of Proof--Mathematical Formulae: Argument of Counsel--Facts not in Evidence.** --In a robbery prosecution, the prosecutor misused mathematical probability statistics in an attempt to show that defendants were the robbers where there was no evidence relating to any of the six individual probability factors used by the prosecutor and ascribed to the distinct characteristics of defendants, and where no proof was presented that the characteristics selected were mutually independent, even though the mathematical expert witness acknowledged that such condition was essential to proper application of the statistical probability rules that he used in his testimony.

**COUNSEL:** Rex K. DeGeorge, under appointment by the Supreme Court, for Defendant and Appellant.

Thomas C. Lynch, Attorney General, William E. James, Assistant Attorney General, and Nicholas C. Yost, Deputy Attorney General, for Plaintiff and Respondent.

**JUDGES:** In Bank. Sullivan, J. Traynor, C. J., Peters, J., Tobriner, J., Mosk, J., and Burke, J., concurred. McComb, J., dissents.

**OPINION BY: SULLIVAN**

#### OPINION

[\*320] [\*\*33] [\*\*\*497] We deal here with the novel question whether evidence of mathematical probability has been properly introduced and used by the prosecution in a criminal case. While we discern no inherent incompatibility between the disciplines of law and mathematics and intend no general disapproval or disparagement of the latter as an auxiliary in the fact-finding processes of the former, we cannot uphold the technique employed in the instant case. **(1a)** As we explain in detail, *infra*, the testimony as to mathematical probability infected the case with fatal error and distorted the jury's traditional role of determining guilt or innocence according to long-settled rules. Mathematics, a veritable sorcerer in our computerized society, while assisting the trier of fact in the search for truth, must not cast a spell over him. We conclude that on the record before us defendant should not have had his guilt determined by the odds and that he is entitled to a new trial. We reverse the judgment.

A jury found defendant Malcolm Ricardo Collins and his wife defendant Janet Louise Collins guilty of second degree [\*321] robbery ( Pen. Code, §§ 211, 211a, 1157). Malcolm appeals from the judgment of conviction. Janet has not appealed.<sup>1</sup>

<sup>1</sup> Hereafter, the term "defendant" is intended to apply only to Malcolm, but the term "defendants" to Malcolm and Janet.

[\*\*34] [\*\*\*498] On June 18, 1964, about 11:30 a.m. Mrs. Juanita Brooks, who had been shopping, was walking home along an alley in the San Pedro area of the City of Los Angeles. She was pulling behind her a wicker basket carryall containing groceries and had her purse on top of the packages. She was using a cane. As she stooped down to pick up an empty carton, she was suddenly pushed to the ground by a person whom she neither saw nor heard approach. She was stunned by the fall and felt some pain. She managed to look up and saw a young woman running from the scene. According to Mrs. Brooks the latter appeared to weigh about 145 pounds, was wearing "something dark," and had hair "between a dark blond and a light blond," but lighter than the color of defendant Janet Collins' hair as it appeared at trial. Immediately after the incident, Mrs. Brooks discovered that her purse, containing between \$ 35 and \$ 40 was missing.

About the same time as the robbery, John Bass, who lived on the street at the end of the alley, was in front of his house watering his lawn. His attention was attracted by "a lot of crying and screaming" coming from the alley. As he looked

in that direction, he saw a woman run out of the alley and enter a yellow automobile parked across the street from him. He was unable to give the make of the car. The car started off immediately and pulled wide around another parked vehicle so that in the narrow street it passed within 6 feet of Bass. The latter then saw that it was being driven by a male Negro, wearing a mustache and beard. At the trial Bass identified defendant as the driver of the yellow automobile. However, an attempt was made to impeach his identification by his admission that at the preliminary hearing he testified to an uncertain identification at the police lineup shortly after the attack on Mrs. Brooks, when defendant was beardless.

In his testimony Bass described the woman who ran from the alley as a Caucasian, slightly over 5 feet tall, of ordinary build, with her hair in a dark blonde ponytail, and wearing dark clothing. He further testified that her ponytail was "just like" one which Janet had in a police photograph taken on June 22, 1964.

On the day of the robbery, Janet was employed as a housemaid [\*322] in San Pedro. Her employer testified that she had arrived for work at 8:50 a.m. and that defendant had picked her up in a light yellow car <sup>2</sup> about 11:30 a.m. On that day, according to the witness, Janet was wearing her hair in a blonde ponytail but lighter in color than it appeared at trial. <sup>3</sup>

<sup>2</sup> Other witnesses variously described the car as yellow, as yellow with an off-white top, and yellow with an egg-shell white top. The car was also described as being medium to large in size. Defendant drove a car at or near the times in question which was a Lincoln with a yellow body and a white top.

<sup>3</sup> There are inferences which may be drawn from the evidence that Janet attempted to alter the appearance of her hair after June 18. Janet denies that she cut, colored or bleached her hair at any time after June 18, and a number of witnesses supported her testimony.

There was evidence from which it could be inferred that defendants had ample time to drive from Janet's place of employment and participate in the robbery. Defendants testified, however, that they went directly from her employer's house to the home of friends, where they remained for several hours.

In the morning of June 22, Los Angeles Police Officer Kinsey, who was investigating the robbery, went to defendants' home. He saw a yellow Lincoln automobile with an off-white top in front of the house. He talked with defendants. Janet, whose hair appeared to be a dark blonde, was wearing it in a ponytail. Malcolm did not have a beard. The officer explained to them that he was investigating a robbery specifying the time and place; that the victim had been knocked down and her purse snatched; and that the person responsible was a female Caucasian with blonde hair in a ponytail [\*35] [\*\*\*499] who had left the scene in a yellow car driven by a male Negro. He requested that defendants accompany him to the police station at San Pedro and they did so. There, in response to police inquiries as to defendants' activities at the time of the robbery, Janet stated, according to Officer Kinsey, that her husband had picked her up at her place of employment at 1 p.m. and that they had then visited at the home of friends in Los Angeles. Malcolm confirmed this. Defendants were detained for an hour or two, were photographed but not booked, and were eventually released and driven home by the police.

Late in the afternoon of the same day, Officer Kinsey, while driving home from work in his own car, saw defendants riding in their yellow Lincoln. Although the transcript fails to disclose what prompted such action, Kinsey proceeded to place them under surveillance and eventually followed them home. He called for assistance and arranged to meet other [\*323] police officers in the vicinity of defendants' home. Kinsey took a position in the rear of the premises. The other officers, who were in uniform and had arrived in a marked police car, approached defendants' front door. As they did so, Kinsey saw defendant Malcolm Collins run out the back door toward a rear fence and disappear behind a tree. Meanwhile the other officers emerged with Janet Collins whom they had placed under arrest. A search was made for Malcolm who was found in a closet of a neighboring home and also arrested. Defendants were again taken to the police station, were kept in custody for 48 hours, and were again released without any charges being made against them.

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(2a) Officer Kinsey interrogated defendants separately on June 23 while they were in custody and testified to their statements over defense counsel's objections based on the decision in *Escobedo* and our first decision in *Dorado*.<sup>4</sup> According to the officer, Malcolm stated that he sometimes wore a beard but that he did not wear a beard on June 18 (the day of the robbery), having shaved it off on June 2, 1964.<sup>5</sup> He also explained two receipts for traffic fines totalling \$ 35 paid on June 19, which receipts had been found on his person, by saying that he used funds won in a gambling game at a labor hall. Janet, on the other hand, said that the \$ 35 used to pay the fines had come from her earnings.<sup>6</sup>

<sup>4</sup> *Escobedo v. Illinois* (378 U.S. 478 [12 L.Ed.2d 977, 84 S.Ct. 1758]) was decided on June 22, 1964, four days after the robbery. The investigation was carried on both before and after *Escobedo* but before our first decision in *People v. Dorado* filed on August 31, 1964. Defendants' trial took place in November 1964 after we granted a rehearing in *Dorado* on September 24, 1964, but before our decision on rehearing filed January 29, 1965. (62 Cal.2d 338 [42 Cal.Rptr. 169, 398 P.2d 361].)

<sup>5</sup> Evidence as to defendant's beard and mustache is conflicting. Defense witnesses appeared to support defendant's claims that he had shaved his beard on June 2. There was testimony that on June 19 when defendant appeared in court to pay fines on another matter he was bearded. By June 22 the beard had been removed.

<sup>6</sup> The source of the \$ 35, being essentially the same amount as the \$ 35 to \$ 40 reported by the victim as having been in her purse when taken from her the day before the fines were paid, was a significant factor in the prosecution's case. Other evidence disclosed that defendant and Janet were married June 2, 1964, at which time they had only \$ 12, a portion of which was spent on a trip to Tiajuana. Since the marriage defendant had not worked, and Janet's earnings were not more than \$ 12 a week, if that much.

On July 9, 1964, defendants were again arrested and were booked for the first time. While they were in custody and awaiting the preliminary hearing, Janet requested to talk with Officer Kinsey. There followed a lengthy conversation [\*324] during the first part of which Malcolm was not present. During this time Janet expressed concern about defendant and inquired as to what the outcome would be *if* it appeared that she committed the crime and Malcolm knew nothing about it. In general she indicated a wish that defendant be released from any charges because of his prior criminal record [\*\*36] [\*\*\*500] and that if someone must be held responsible, she alone would bear the guilt. The officer told her that no assurances could be given, that if she wanted to admit responsibility disposition of the matter would be in the hands of the court and that if she committed the crime and defendant knew nothing about it the only way she could help him would be by telling the truth. Defendant was then brought into the room and participated in the rest of the conversation. The officer asked to hear defendant's version of the matter, saying that he believed defendant was at the scene. However, neither Janet nor defendant confessed or expressly made damaging admissions although constantly urged by the investigating officer to make truthful statements. On several occasions defendant denied that he knew what had gone on in the alley. On the other hand, the whole tone of the conversation evidenced a strong consciousness of guilt on the part of both defendants who appeared to be seeking the most advantageous way out. Over defense counsel's same objections based on *Escobedo* and *Dorado*, some parts of the foregoing conversation were testified to by Officer Kinsey and in addition a tape recording of the entire conversation was introduced in evidence and played to the jury.<sup>7</sup>

<sup>7</sup> Included in the conversation are the following excerpts from Janet's statements:

"If I told you that he didn't know anything about it and I did it, would you cut him loose?"

"I just want him out, that's all, because I ain't never been in no trouble. I won't have to do too much [time], but he will."

"What's the most time I can do?"

"Would it be easier if I went ahead and said, if I was going to say anything, say it now instead of waiting till court time?"

Defendant indicated that he should "go and have trust in [the officer], but maybe I'd be wrong. I mean, this is a little delicate on my behalf."

At another point defendant stated: "I'm leaving it up to her."

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Defendant expressed concern during the conversation that any statement by Janet would not necessarily relieve him because he admittedly had been with her all that day since 11:30 a.m. The conversation closed when defendants indicated that they wished more time to think it over.

At the seven-day trial the prosecution experienced some difficulty in establishing the identities of the perpetrators of the crime. The victim could not identify Janet and had never seen defendant. The identification by the witness Bass, who [\*325] observed the girl run out of the alley and get into the automobile, was incomplete as to Janet and may have been weakened as to defendant. There was also evidence, introduced by the defense, that Janet had worn light-colored clothing on the day in question, but both the victim and Bass testified that the girl they observed had worn dark clothing.

In an apparent attempt to bolster the identifications, the prosecutor called an instructor of mathematics at a state college. Through this witness he sought to establish that, assuming the robbery was committed by a Caucasian woman with a blond ponytail who left the scene accompanied by a Negro with a beard and mustache, there was an overwhelming probability that the crime was committed by any couple answering such distinctive characteristics. The witness testified, in substance, to the "product rule," which states that the probability of the joint occurrence of a number of *mutually independent* events is equal to the product of the individual probabilities that each of the events will occur.<sup>8</sup> Without presenting any statistical evidence whatsoever in support of the probabilities for the factors selected, the prosecutor then proceeded to have the witness *assume*<sup>9</sup> probability [\*37] [\*\*\*501] factors for the various characteristics which he deemed to be shared by the guilty couple and all other couples answering to such distinctive characteristics.<sup>10</sup>

<sup>8</sup> In the example employed for illustrative purposes at the trial, the probability of rolling one die and coming up with a "2" is 1/6, that is, any one of the six faces of a die has one chance in six of landing face up on any particular roll. The probability of rolling two "2's" in succession is 1/6 X 1/6, or 1/36, that is, on only one occasion out of 36 double rolls (or the roll of two dice), will the selected number land face up on each roll or die.

<sup>9</sup> His argument to the jury was based on the same gratuitous assumptions or on similar assumptions which he invited the jury to make.

<sup>10</sup> Although the prosecutor insisted that the factors he used were only for illustrative purposes -- to demonstrate how the probability of the occurrence of mutually independent factors affected the probability that they would occur together -- he nevertheless attempted to use factors which he personally related to the distinctive characteristics of defendants. In his argument to the jury he invited the jurors to apply their own factors, and asked defense counsel to suggest what the latter would deem as reasonable. The prosecutor himself proposed the individual probabilities set out in the table below. Although the transcript of the examination of the mathematics instructor and the information volunteered by the prosecutor at that time create some uncertainty as to precisely which of the characteristics the prosecutor assigned to the individual probabilities, he restated in his argument to the jury that they should be as follows:

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

In his brief on appeal defendant agrees that the foregoing appeared on a table presented in the trial court.

Applying the product rule to his own factors the prosecutor arrived at a probability that there was but one chance in 12 million that any couple possessed the distinctive characteristics of the defendants. Accordingly, under this theory, it was to be inferred that there could be but one chance in 12 million that defendants were innocent and that another equally distinctive couple actually committed the robbery. Expanding on what he had thus purported to suggest as a

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hypothesis, the [\*326] prosecutor offered the completely unfounded and improper testimonial assertion that, in his opinion, the factors he had assigned were "conservative estimates" and that, in reality, "the chances of anyone else besides these defendants being there, . . . having every similarity, . . . is something like one in a billion."

Objections were timely made to the mathematician's testimony on the grounds that it was immaterial, that it invaded the province of the jury, and that it was based on unfounded assumptions. The objections were "temporarily overruled" and the evidence admitted subject to a motion to strike. When that motion was made at the conclusion of the direct examination, the court denied it, stating that the testimony had been received only for the "purpose of illustrating the mathematical probabilities of various matters, the possibilities for them occurring or re-occurring."

Both defendants took the stand in their own behalf. They denied any knowledge of or participation in the crime and stated that after Malcolm called for Janet at her employer's house they went directly to a friend's house in Los Angeles where they remained for some time. According to this testimony defendants were not near the scene of the robbery when it occurred. Defendants' friend testified to a visit by them "in the middle of June" although she could not recall the precise date. Janet further testified that certain inducements were held out to her during the July 9 interrogation on condition that she confess her participation.

Defendant makes two basic contentions before us: First, that the admission in evidence of the statements made by defendants [\*\*38] [\*\*\*502] while in custody on June 23 and July 9, 1964, [\*327] constitutes reversible error under the rules announced in the *Escobedo* and *Dorado* decisions;<sup>11</sup> and second, that the introduction of evidence pertaining to the mathematical theory of probability and the use of the same by the prosecution during the trial was error prejudicial to defendant. We consider the latter claim first.

<sup>11</sup> *Escobedo v. Illinois* (1964) 378 U.S. 478 [12 L.Ed.2d 977, 84 S.Ct. 1758]; *People v. Dorado* (1965) 62 Cal.2d 338 [42 Cal.Rptr. 169, 398 P.2d 361].

(3a) As we shall [HN1] explain, the prosecution's introduction and use of mathematical probability statistics injected two fundamental prejudicial errors into the case: (1) The testimony itself lacked an adequate foundation both in evidence and in statistical theory; and (2) the testimony and the manner in which the prosecution used it distracted the jury from its proper and requisite function of weighing the evidence on the issue of guilt, encouraged the jurors to rely upon an engaging but logically irrelevant expert demonstration, foreclosed the possibility of an effective defense by an attorney apparently unschooled in mathematical refinements, and placed the jurors and defense counsel at a disadvantage in sifting relevant fact from inapplicable theory.

(4) We initially consider the defects in the testimony itself. As we have indicated, the specific technique presented through the mathematician's testimony and advanced by the prosecutor to measure the probabilities in question suffered from two basic and pervasive defects -- an inadequate evidentiary foundation and an inadequate proof of statistical independence. First, as to the foundational requirement, we find the record devoid of any evidence relating to any of the six individual probability factors used by the prosecutor and ascribed by him to the six characteristics as we have set them out in footnote 10, *ante*. To put it another way, the prosecution produced no evidence whatsoever showing, or from which it could be in any way inferred, that only one out of every ten cars which might have been at the scene of the robbery was partly yellow, that only one out of every four men who might have been there wore a mustache, that only one out of every ten girls who might have been there wore a ponytail, or that any of the other individual probability factors listed were even roughly accurate.<sup>12</sup>

<sup>12</sup> We seriously doubt that such evidence could ever be compiled since no statistician could possibly determine after the fact which cars, or which individuals, "might" have been present at the scene of the robbery; certainly there is no reason to suppose that the human and

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automotive populations of San Pedro, California, include all potential culprits -- or, conversely, that all members of these populations are proper candidates for inclusion. Thus the sample from which the relevant probabilities would have to be derived is itself undeterminable. (See generally, Yamane, *Statistics, An Introductory Analysis* (1964), ch. I.)

[\*328] The bare, inescapable fact is that the prosecution made no attempt to offer any such evidence. Instead, through leading questions having perfunctorily elicited from the witness the response that the latter could not assign a probability factor for the characteristics involved,<sup>13</sup> the prosecutor himself suggested what the various probabilities should be and these became the basis of the witness' testimony (see fn. 10, *ante*). It is a curious circumstance of this adventure in proof that the prosecutor not only made his own assertions of these factors in the hope that they were "conservative" but also in later argument to the jury invited the jurors to substitute their "estimates" should they wish to do so. [\*\*39] [\*\*\*503] We can hardly conceive of a more fatal gap in the prosecution's scheme of proof. A foundation for the admissibility of the witness' testimony was never even attempted to be laid, let alone established. His testimony was neither made to rest on his own testimonial knowledge nor presented by proper hypothetical questions based upon valid data in the record. (See generally: 2 Wigmore on Evidence (3d ed. 1940) §§ 478, 650-652, 657, 659, 672-684; Witkin, *Cal. Evidence* (2d ed. 1966) § 771; McCormick on Evidence, pp. 19-20; *Evidence: Admission of Mathematical Probability Statistics Held Erroneous for Want of Demonstration of Validity* (1967) Duke L.J. 665, 675-678, citing *People v. Risley* (1915) 214 N.Y. 75, 85 [108 N.E. 200, Ann. Cas. 1916 D 775]; *State v. Sneed* (1966) 76 N.M. 349 [414 P.2d 858].) In the *Sneed* case, the court reversed a conviction based on probabilistic evidence, stating: "We hold that [HN2] 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 [*sic*] not been demonstrated." (Italics added.) (414 P.2d at p. 862.)

13 The prosecutor asked the mathematics instructor: "Now, let me see if you can be of some help to us with some independent factors, and you have some paper you may use. Your specialty does not equip you, I suppose, to give us some probability of such things as a yellow car as contrasted with any other kind of car, does it? . . . I appreciate the fact that you can't assign a probability for a car being yellow as contrasted to some other car, can you? A. No, I couldn't."

But, as we have indicated, there was another glaring defect in the prosecution's technique, namely an inadequate proof of the statistical independence of the six factors. No proof was presented that the characteristics selected were mutually independent, even though the witness himself acknowledged that such condition was essential to the proper application of the "product rule" or "multiplication rule." (See Note, [\*329] *supra*, Duke L.J. 665, 669-670, fn. 25.)<sup>14</sup> To the extent that the traits or characteristics were not mutually independent (e.g., Negroes with beards and men with mustaches obviously represent overlapping categories<sup>15</sup>), the "product rule" would inevitably yield a wholly erroneous and exaggerated result even if all of the individual components had been determined with precision. (Siegel, *Nonparametric Statistics for the Behavioral Sciences* (1956) 19; see generally Harmon, *Modern Factor Analysis* (1960).)

14 It is there stated that: "A trait is said to be independent of a second trait when the occurrence or nonoccurrence 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." (Citing Huntsberger, *Elements of Statistical Inference* (1961) 77; Kingston & Kirk, *The Use of Statistics in Criminalistics* (1964) 55 J. Crim. L., C. & P.S. 516.) (Note, *supra*, Duke L.J. fn. 25, p. 670.)

15 Assuming *arguendo* that factors B and E (see fn. 10, *ante*), were correctly estimated. nevertheless it is still arguable that most Negro men with beards *also* have mustaches (exhibit 3 herein, for instance, shows defendant with both a mustache and a beard, indeed in a hirsute continuum); if so, there is no basis for multiplying 1/4 by 1/10 to estimate the proportion of Negroes who wear beards *and* mustaches. Again, the prosecution's technique could *never* be meaningfully applied, since its accurate use would call for information as to the degree of interdependence among the six individual factors. (See Yamane, *op. cit. supra*.) Such information cannot be compiled, however, since the relevant sample necessarily remains unknown. (See fn. 10, *ante*.)



[HN3] In the instant case, therefore, because of the aforementioned two defects -- the inadequate evidentiary foundation and the inadequate proof of statistical independence -- the technique employed by the prosecutor could only lead to wild conjecture without demonstrated relevancy to the issues presented. It acquired no redeeming quality from the prosecutor's statement that it was being used only "for illustrative purposes" since, as we shall point out, the prosecutor's subsequent utilization of the mathematical testimony was not confined within such limits.

(3b) We now turn to the second fundamental error caused by the probability testimony. Quite apart from our foregoing objections to the specific technique employed by the prosecution to estimate the probability in question, we think that the entire enterprise upon which the prosecution embarked [\*\*40] [\*\*\*504] and which was directed to the objective of measuring the likelihood of a random couple possessing the characteristics allegedly distinguishing the robbers, was gravely misguided. [\*330] At best, it might yield an estimate as to how infrequently bearded Negroes drive yellow cars in the company of blonde females with ponytails.

The prosecution's approach, however, could furnish the jury with absolutely no guidance on the crucial issue: *Of the admittedly few such couples, which one, if any, was guilty of committing this robbery?* Probability theory necessarily remains silent on that question, [HN4] since no mathematical equation can prove beyond a reasonable doubt (1) that the guilty couple *in fact* possessed the characteristics described by the People's witnesses, or even (2) that only *one* couple possessing those distinctive characteristics could be found in the entire Los Angeles area.

As to the first inherent failing we observe that the prosecution's theory of probability rested on the assumption that the witnesses called by the People had conclusively established that the guilty couple possessed the precise characteristics relied upon by the prosecution. But no mathematical formula could ever establish beyond a reasonable doubt that the prosecution's witnesses correctly observed and accurately described the distinctive features which were employed to link defendants to the crime. (See 2 Wigmore on Evidence (3d ed. 1940) § 478.) Conceivably, for example, the guilty couple might have included a light-skinned Negress with bleached hair rather than a Caucasian blonde; or the driver of the car might have been wearing a false beard as a disguise; or the prosecution's witnesses might simply have been unreliable.<sup>16</sup>

<sup>16</sup> In the instant case, for instance, the victim could not state whether the girl had a ponytail, although the victim observed the girl as she ran away. The witness Bass, on the other hand, was sure that the girl whom he saw had a ponytail. The demonstration engaged in by the prosecutor also leaves no room for the possibility, although perhaps a small one, that the girl whom the victim and the witness observed was, in fact, the same girl.

The foregoing risks of error permeate the prosecution's circumstantial case. Traditionally, the jury weighs such risks in evaluating the credibility and probative value of trial testimony, but the likelihood of human error or of falsification obviously cannot be quantified; that likelihood must therefore be excluded from any effort to assign a *number* to the probability of guilt or innocence. Confronted with an equation which purports to yield a numerical index of probable guilt, few juries could resist the temptation to accord disproportionate weight to that index; only an exceptional juror, and indeed only a defense attorney schooled in mathematics, could successfully keep in mind the fact that the probability computed [\*\*331] by the prosecution can represent, *at best*, the likelihood that a random couple would share the characteristics testified to by the People's witnesses -- *not necessarily the characteristics of the actually guilty couple*.

As to the second inherent failing in the prosecution's approach, even assuming that the first failing could be discounted, the most a mathematical computation could *ever* yield would be a measure of the probability that a random couple would possess the distinctive features in question. In the present case, for example, the prosecution attempted to compute the probability that a random couple would include a bearded Negro, a blonde girl with a ponytail, and a partly

yellow car; the prosecution urged that this probability was no more than one in 12 million. Even accepting this conclusion as arithmetically accurate, however, one still could not conclude that the Collinses were probably *the* guilty couple. On the contrary, as we explain in the Appendix, the prosecution's figures actually imply a likelihood of over 40 percent that the Collinses could be "duplicated" by at least *one other couple who might equally have committed the San Pedro robbery*. Urging that the Collinses [\*\*41] [\*\*\*505] be convicted on the basis of evidence which logically establishes no more than this seems as indefensible as arguing for the conviction of X on the ground that a witness saw either X or X's twin commit the crime.

Again, few defense attorneys, and certainly few jurors, could be expected to comprehend this basic flaw in the prosecution's analysis. Conceivably even the prosecutor erroneously believed that his equation established a high probability that *no* other bearded Negro in the Los Angeles area drove a yellow car accompanied by a ponytailed blonde. In any event, although his technique could demonstrate no such thing, he solemnly told the jury that he had supplied mathematical proof of guilt.

(1b) Sensing the novelty of that notion, the prosecutor told the jurors that the traditional idea of proof beyond a reasonable doubt represented "the most hackneyed, stereotyped, trite, misunderstood concept in criminal law." He sought to reconcile the jury to the risk that, under his "new math" approach to criminal jurisprudence, "on some rare occasion . . . an innocent person may be convicted." "Without taking that risk," the prosecution continued, "life would be intolerable . . . because . . . there would be immunity for the Collinses, for people who chose not to be employed to go down and push old ladies down and take their money and be [\*332] immune because how could we ever be sure they are the ones who did it?"

In essence this argument of the prosecutor was calculated to persuade the jury to convict defendants whether or not they were convinced of their guilt to a moral certainty and beyond a reasonable doubt. ( Pen. Code, § 1096.) Undoubtedly the jurors were unduly impressed by the mystique of the mathematical demonstration but were unable to assess its relevancy or value. (3c) Although we make no appraisal of the proper applications of mathematical techniques in the proof of facts (see *People v. Jordan* (1955) 45 Cal.2d 697, 707 [290 P.2d 484]; *People v. Trujillo* (1948) 32 Cal.2d 105, 109 [194 P.2d 681]; in a slightly differing context see *Whitus v. Georgia* (1967) 385 U.S. 545, 552, fn. 2 [17 L.Ed.2d 599, 604, 87 S.Ct. 643]; Finkelstein, *The Application of Statistical Decision Theory to the Jury Discrimination Cases* (1966) 80 Harv.L.Rev. 338, 338-340), we have strong feelings that such applications, particularly in a criminal [HN5] case, must be critically examined in view of the substantial unfairness to a defendant which may result from ill conceived techniques with which the trier of fact is not technically equipped to cope. (See *State v. Sneed, supra*, 414 P.2d 858; Note, *supra*, Duke L.J. 665.) We feel that the technique employed in the case before us falls into the latter category.

(1c) We conclude that the court erred in admitting over defendant's objection the evidence pertaining to the mathematical theory of probability and in denying defendant's motion to strike such evidence. The case was apparently a close one. The jury began its deliberations at 2:46 p.m. on November 24, 1964, and retired for the night at 7:46 p.m.; the parties stipulated that a juror could be excused for illness and that a verdict could be reached by the remaining 11 jurors; the jury resumed deliberations the next morning at 8:40 a.m. and returned verdicts at 11:58 a.m. after five ballots had been taken. In the light of the closeness of the case, which as we have said was a circumstantial one, there is a reasonable likelihood that the result would have been more favorable to defendant if the prosecution had not urged the jury to render a probabilistic verdict. In any event, we think that under the circumstances the "trial by mathematics" so distorted the role of the jury and so disadvantaged counsel for the defense, as to constitute in itself a miscarriage of justice. After an examination of the entire cause, including the evidence, we are of the opinion that it is reasonably probable that a result [\*333] more favorable to defendant would have been reached in the absence of the [\*\*42] [\*\*\*506] above error. (*People v. Watson* (1956) 46 Cal.2d 818, 836 [299 P.2d 243].) The judgment against defendant must therefore be reversed.

(2b) In view of the foregoing conclusion, we deem it unnecessary to consider whether the admission of defendants' extrajudicial statements constitutes error under the rules announced in *Escobedo* and *Dorado*. Upon retrial, the

admissibility of these or any other extrajudicial statements sought to be introduced by the prosecution must be determined in the light of the rules set forth in *Miranda v. Arizona* (1966) 384 U.S. 436 [16 L.Ed.2d 694, 86 S.Ct. 1602, 10 A.L.R.3d 974]. (*People v. Doherty* (1967) 67 Cal.2d 9, 12, 17-21 [59 Cal.Rptr. 857, 429 P.2d 177].) As we have pointed out, the trial herein took place between our first and second *Dorado* decisions (see fn. 4, *ante*). Although defense counsel was commendably alert in basing objections to the admission of the statements upon the decisions in *Escobedo* and *Dorado*, he of course did not have the benefit of our numerous decisions beginning with the second *Dorado* decision expounding various facets of the exclusionary rule. In the event any extrajudicial statements made by defendant are offered in evidence on retrial, the parties will have an opportunity to make a record on pertinent issues subject to prior determination by the court in the light of *Miranda* rules before such statements are received in evidence. It would be fruitless for us to essay such a task at this point when such record does not yet exist.

The judgment is reversed.

#### Appendix

If "Pr" represents the probability that a certain distinctive combination of characteristics, hereinafter designated "C," will occur jointly in a random couple, then the probability that C will *not* occur in a random couple is  $(1 - \text{Pr})$ . Applying the product rule (see fn. 8, *ante*), the probability that C will occur in *none* of N couples chosen at random is  $(1 - \text{Pr})^N$ , so that the probability of C occurring in *at least one* of N random couples is  $[1 - (1 - \text{Pr})^N]$ .

[\*334] Given a particular couple selected from a random set of N, the probability of C occurring in that couple (i.e., Pr), multiplied by the probability of C occurring in none of the remaining  $N - 1$  couples (i.e.,  $(1 - \text{Pr})^{N - 1}$ ), yields the probability that C will occur in the selected couple and in no other. Thus the probability of C occurring in any particular couple, and in that couple alone, is  $[\text{Pr} \times (1 - \text{Pr})^{N - 1}]$ . Since this is true for each of the N couples, the probability that C will occur in precisely *one* of the N couples, without regard to which one, is  $[\text{Pr} \times (1 - \text{Pr})^{N - 1}]$  added N times, because the probability of the occurrence of one of several *mutually exclusive* events is equal to the *sum* of the individual probabilities. Thus the probability of C occurring in *exactly one* of N random couples (*any one*, but *only one*) is  $[N \times \text{Pr} \times (1 - \text{Pr})^{N - 1}]$ .

By subtracting the probability that C will occur in *exactly one* couple from the probability that C will occur in *at least one* couple, one obtains the probability that C will occur in *more than one* couple:  $[1 - (1 - \text{Pr})^N] - [N \times \text{Pr} \times (1 - \text{Pr})^{N - 1}]$ . Dividing this difference by the probability that C will occur in at least one couple (i.e., dividing the difference by  $[1 - (1 - \text{Pr})^N]$ ) then yields *the probability that C will occur more than once in a group of N couples in which C occurs at least once*.

Turning to the case in which C represents the characteristics which distinguish a bearded Negro accompanied by a ponytailed blonde in a yellow car, the prosecution sought to establish that the probability of C occurring in a random couple was  $1/12,000,000$  -- i.e., that  $\text{Pr} = 1/12,000,000$ . Treating this conclusion as accurate, it follows that, in a population of N random [\*43] [\*\*\*507] couples, the probability of C occurring *exactly once* is  $[N \times (1/12,000,000) \times (1 - 1/12,000,000)^{N - 1}]$ . Subtracting this product from  $[1 - (1 - 1/12,000,000)^N]$ , the probability of C occurring in *at least one* couple, and dividing the resulting difference by  $[1 - (1 - 1/12,000,000)^N]$ , the probability that C will occur in at least one couple, yields the probability that C will occur more than once in a group of N random couples of which at least one couple (namely, the one seen by the witnesses) possesses characteristics C. In other words, the probability of *another* such couple in a population of N is the quotient A/B, where A designates the numerator  $[1 - (1 - 1/12,000,000)^N] - [N \times (1/12,000,000) \times (1 - 1/12,000,000)^{N - 1}]$ , and B designates the denominator  $[1 - (1 - 1/12,000,000)^N]$ .

[\*335] N, which represents the total number of all couples who might conceivably have been at the scene of the San Pedro robbery, is not determinable, a fact which suggests yet another basic difficulty with the use of probability theory in establishing identity. One of the imponderables in determining N may well be the number of N-type couples in which a single person may participate. Such considerations make it evident that N, in the area adjoining the robbery, is

68 Cal. 2d 319, \*; 438 P.2d 33, \*\*43;  
66 Cal. Rptr. 497, \*\*\*507; 1968 Cal. LEXIS 167

in excess of several million; as N assumes values of such magnitude, the quotient A/B computed as above, representing the probability of a second couple as distinctive as the one described by the prosecution's witnesses, soon exceeds 4/10. Indeed, as N approaches 12 million, this probability quotient rises to approximately 41 percent. We note parenthetically that if  $1/N = Pr$ , then as N increases indefinitely, the quotient in question approaches a limit of  $(e - 2)/(e - 1)$ , where "e" represents the transcendental number (approximately 2.71828) familiar in mathematics and physics.

Hence, even if we should accept the prosecution's figures without question, we would derive a probability of over 40 percent that the couple observed by the witnesses could be "duplicated" by at least one other equally distinctive interracial couple in the area, including a Negro with a beard and mustache, driving a partly yellow car in the company of a blonde with a ponytail. Thus the prosecution's computations, far from establishing beyond a reasonable doubt that the Collinses were the couple described by the prosecution's witnesses, imply a very substantial likelihood that the area contained *more than one* such couple, and that a couple *other* than the Collinses was the one observed at the scene of the robbery. (See generally: Hoel, Introduction to Mathematical Statistics (3d ed. 1962); Hodges & Leymann, Basic Concepts of Probability and Statistics (1964); Lindgren & McElrath, Introduction to Probability and Statistics (1959).)

**DISSENT BY: McCOMB**

**DISSENT**

[\*333contd] [EDITOR'S NOTE: The page numbers of this document may appear to be out of sequence; however, this pagination accurately reflects the pagination of the original published documents.]

McCOMB, J. I dissent. I would affirm the judgment in its entirety.