INTERPRETATIVE ARGUMENTS OF FORENSIC MATCH EVIDENCE: AN EVIDENTIARY ANALYSIS

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The use of forensic match evidence contains an unavoidable paradox: that while it might be more reliable and precise than other forms of evidence, there exists a very real danger that jurors will misapprehend its value, given its quantitative nature. The adversarial process in which attorneys present interpretative arguments designed to bolster their clients' interests exacerbates this problem. Thompson and Schumann, who coined the Defense Attorney's Fallacy, conducted the seminal exploration of this issue. This fallacy, along with the Prosecutor's Fallacy, is pervasive throughout academic literature and has been observed in judicial reasoning. There has been no effort, however, to explore its normative status. By exploring the argument that leads to the Defense Attorney's Fallacy, this article argues that the underlying reasoning, while intuitively correct, is normatively incongruent. Using an example of database trawling, the article further seeks to elucidate the evidentiary distinction between relevance and sufficiency, which seems lost when commentators discuss the fallacy of the defense attorney. Recognizing this distinction yields refinement in argument and advances clarity in the logical relationship between forensic match evidence and adjudicative determinations of guilt.

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I. TRIAL BY STATISTICS

The use of quantitative or statistical evidence has been responsible for a plethora of academic discourse. Initially, the debate was about the utility of such evidence. While conventional wisdom held that that jurors would over-utilize statistical evidence,[1] there was much commentary to the

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[1] Laurence Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 HARV. L. REV. 1329 (1971); *cf.* Laurence Tribe, *A Further Critique of Mathematical Proof*, 84 HARV. L. REV. 1810 (1971).

contrary—some arguing that statistics would, if anything, be under-utilized by fact-finders.[2] As this debate concerns an empirical question,[3] Thompson and Schumann, on the other hand, considered questions outside simple utility.[4] They tested various ways in which jurors could misinterpret statistical evidence and examined whether jurors could detect underlying fallacious reasoning when presented with a statistical interpretation or argument.

Thompson and Schumann's first study found that statistical evidence could engender partiality depending on its format;[5] that is, the conclusion drawn from equivalent numerical information would favor either the prosecution or the defense.[6] The way in which statistical data were aggregated, leading to this partiality, is clearly misguided and fundamentally flawed and was therefore termed a "fallacy."[7]

Since argumentation is endemic to the trial process, Thompson and

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[2] Michael J. Saks and Robert F. Kidd, *Human Information Processing and Adjudication: Trial by Heuristics*, 15 LAW & SOC'Y REV. 123 (1980); Michael O. Finkelstein and William Fairley, *A Comment on "Trial by Mathematics"*, 84 HARV. L. REV. 1801 (1971); Michael O. Finkelstein and William Fairley, *A Bayesian Approach to Identification Evidence*, 83 HARV. L. REV. 489 (1970).

[3] *See, e.g.*, David Faigman and A.J. Baglioni, *Bayes' Theorem in the Trial Process: Instructing Jurors on the Value of Statistical Evidence*, 12 LAW & HUM. BEHAV. 1 (1988); Jane Goodman, *Probabilistic Scientific Evidence: Jurors' Inferences* (1988) (unpublished Ph.D. dissertation, University of Washington) (on file with author); William C. Thompson, *Are Juries Competent to Evaluate Statistical Evidence?*, 52 LAW & CONTEMP. PROBS. 9 (1989); Brian C. Smith et al., *Jurors' Use of Probabilistic Evidence*, 20 LAW & HUM. BEHAV. 49 (1996); David H. Kaye and Jonathan J. Koehler, *Can Jurors Understand Probabilistic Evidence?*, 154 J. ROYAL STAT. SOC'Y 75 (1991); Edward J. Imwinkelried, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 28 VILL. L. REV. 554, 566-68 (1983) (reviewing studies showing that jurors are not overly influenced by scientific proof); David H. Kaye et al., *Statistics in the Jury Box: How Jurors Respond to Mitochondrial DNA Match Probabilities*, 4 J. EMPIRICAL LEGAL STUD. 4, 797-834 (2007); Dale A. Nance and Scott B. Morris, *Juror Understanding of DNA Evidence: An Empirical Assessment of Presentation Formats for Trace Evidence with a Relatively Small Random-match Probability*, 34 J. LEGAL STUD. 395 (2005); Jason Schklar and Shari Seidman Diamond, *Juror Reactions to DNA Evidence: Errors and Expectancies*, 23 LAW & HUM. BEHAV. 159 (1999); Jonathan J. Koehler, Audrey Chia and Samuel Lindsey, *The Random Match Probability (RMP) in DNA Evidence: Irrelevant and Prejudicial?*, 35 JURIMETRICS J. 201 (1995).

[4] William C. Thompson and Edward L. Schumann, *Interpretation of Statistical Evidence in Criminal Trials: The Prosecutor's Fallacy and The Defense Attorney's Fallacy*, 11 LAW & HUM. BEHAV. 167 (1987).

[5] *Id.* at 174-6

[6] Information was presented as either conditional probabilities or as simple numbers (percentages). Conditional probabilities led to interpretations favoring the prosecution while simple numbers led to interpretations favoring the defense. *Id.* at 174.

[7] The Prosecutor's aggregation fallacy equates the frequency of a random match with the probability of innocence. For example, if the probability of a random match is 5%, the prosecutor would assume there is a 5% chance the defendant is innocent and hence there is a 95% chance he is guilty. This line of reasoning transposes the conditional probabilities from the probability of the match given innocence (p(M|I)) to the probability of innocence given the match (p(I|M)), which is inappropriate to do without accounting for the prior probability.

Schumann sought to increase the practical significance of their findings by examining the ways in which subjects respond to fallacious interpretative arguments. Their second experiment presented subjects with putatively biased interpretative arguments. An argument favoring the defense, for example, reads as follows:

> Suppose the defendant and perpetrator share a blood type possessed by only 1% of the population. Victims of the (defense) fallacy reason that in a city of 1 million people there would be approximately 10,000 people with this blood type. They conclude there is little if any relevance in the fact that the defendant and perpetrator both belong to such a large group (171).

Thompson and Schumann describe why this reasoning falters:

> What this reasoning fails to take into account, of course, is that the great majority of people with the relevant blood type are not suspects in the case at hand. The evidence drastically narrows the group of people who are or could have been suspects, while failing to exclude the defendant (171).[8]

Presented with this type of argument, Thompson and Schumann found that a majority of subjects endorsed the defense argument as correct, while only a small minority considered the prosecutor's fallacy to be correct.

These fallacies have come to be quite pervasive in academic literature[9] and have even found their way into judicial dictum.[10] Courts have observed these fallacies to be a "very real danger"[11] but have stated dogmatically that careful oversight and proper explanation can easily

[8] Thompson and Schumann, *supra* note 4 at 183 ("The associative evidence drastically narrows the class of people who could have committed the crime, but fails to eliminate the very individual on whom suspicion has already focused.").

[9] *See, e.g.*, Jonathan J. Koehler, *The Psychology of Numbers in the Court Room: How to Make DNA-Match Statistics Seems Impressive or Insufficient*, 74 S. CAL. L. REV. 1275 (2001); William C. Leung, *The Prosecutor's Fallacy—A Pitfall in Interpreting Probabilities in Forensic Evidence*, 42 MED. SCI. & L. 44 (2002); R.A. Matthews, *Inference with Legal Evidence: Common Sense Is Necessary but Not Sufficient*, 44 MED. SCI. & L. 189 (2004); David J. Balding and Peter Donnelly, *The Prosecutor's Fallacy and DNA Evidence*, CRIM. L. REV. 711 (1994).

[10] *See* Jonathan J. Koehler, *Error and Exaggeration in the Presentation of DNA Evidence at Trial*, 34 JURIMETRICS J. 21, 28 n.24 (1993) (documenting instances where courts, commentators and expert witnesses have committed such errors).

[11] U.S. v. Morrow, 374 F.Supp.2d 51 (2005).

overcome these obstacles.[12] Implicit in the judicial and academic discussions of the defense attorney's fallacy[13] is an assumption of veracity—that the fallacy is indeed fallacious. This paper evaluates the reasoning that underlies the defense fallacy from a normative perspective. Safeguards exist to promote equity in the trial process. Such safeguards are normative in the prescriptive sense that they *ought* to be followed, even if they defy common sense or intuition. From this perspective, the status of the defense fallacy is questionable, and at least noticeably more complicated than is often assumed. Moreover, the way in which the fallacy is worded is unclear and often confused from an evidentiary standpoint. From the onset of this analysis, it should be noted that the defense fallacy is used for the sake of illustration, but that the principles discussed herein generalize to other interpretative arguments of forensic match evidence.

II. A SUBSTANTIVE ARGUMENT: THE PRESUMPTION OF INNOCENCE

Within the generic argument of the defense attorney, there seems to be an implicit concession that the reasoning is correct, but that the logic only becomes fallacious if additional conditions are to be considered; namely, the fact that the defendant has been singled out and put on trial while the other 9,999 who share the same blood type have not. In effect, the corroborating evidence that the perpetrator is in fact *this* defendant, and not one of the other 9,999 persons with the same blood type, is that this particular defendant is on trial. Furthermore, one could infer from the fact he is on trial that there is additional evidence to implicate this particular defendant in the crime at hand. If these additional conditions are in fact considered, it follows that the defense argument is fallacious—but these specific considerations *ipso facto* violate the Presumption of Innocence.

A fundamental tenet of the criminal justice system is the right to be presumed innocent until proven guilty. One function of this Presumption is to indicate which party must prove the necessary facts to prevail, the absence of which would result in a judgment for the non-initiating party.[14] Hence, some view the Presumption as functionally synonymous with the standard of persuasion, since innocence is assumed unless the standard is satisfied.[15] However, not all commentators accept the synonymy conceptualization. Some argue that the function of the Presumption is to

[12] *Id.*; U.S. v. Chischilly 30 F.3d 1144 (1994); *but see* Smith et al., *supra* note 3 (demonstrating that with instruction on Bayes' Theorem, jurors were less likely to succumb to the defense fallacy).
[13] Kaye et al., *supra* note 3, at 804 (preferring to call the defense fallacy the "relevance fallacy").
[14] Coffin v. United States, 156 U.S. 432, 453 (1895); *In re* Winship, 397 U.S. 358, 363 (1970).
[15] Scott Sundby, *The Reasonable Doubt Rule and the Meaning of Innocence*, 40 HASTINGS L.J. 457 (1989).

indicate the point of departure from which jurors should begin their consideration of the evidence in the present case.[16] From a logical standpoint, the different standards of persuasion, which require varying levels of proof and which vary with legal application, are a meaningless idealization without some notion of a beginning point. Without knowing from whence one begins, knowledge of the finish line is of limited meaning and consequence.

Although it has neglected to specify such a point with any numerical precision, the Supreme Court mapped out some substantive parameters for a suitable beginning. Most notably, the fact that a defendant is on trial may not be used as evidence of guilt, the Court explained, as guilt is to be determined by the evidence presented at trial.[17] This has led some commentators to interpret the Presumption as requiring jurors to view a defendant as if he or she were equally likely as anyone else to be guilty—in other words, as if the defendant were randomly selected and put on trial.[18] Richard D. Friedman[19] goes even further, writing that the correct formulation requires a juror to begin a trial not only with the presumption that the defendant did not commit a crime, but also that no crime has been committed.[20]

Based on the substantive parameters of the presumption of innocence, it is clear that indictment and trial should not be, in and of

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[16] *E.g.*, Richard D. Friedman, *A Presumption of Innocence, Not of Even Odds*, 52 STAN. L. REV. 873, 883 (2000) ("It is important that the presumption of innocence and the standard of persuasion not be confused. The presumption of innocence tells the jurors where they should begin consideration of the case. The standard of persuasion tells the jurors where they must end if they are to convict.").

[17] Taylor v. Kentucky, 436 U.S. 478 (1978) ("[O]ne accused of a crime is entitled to have his guilt or innocence determined solely on the basis of the evidence introduced at trial, and not on grounds of official suspicion, indictment, continued custody, or other circumstances not adduced as proof at trial.").

[18] David H. Kaye, *The Laws of Probability and the Law of the Land*, 47 U. CHI. L. REV. 34, 52 (1979); *cf.* David H. Kaye and David J. Balding, *Probability and Proof in* State v. Skipper*: An Internet Exchange*, 35 JURIMETRICS J. 277, 292 (1995) citing A. Philip Dawid, *The Island Problem: Coherent Use of Identification Evidence*, *in* ASPECTS OF UNCERTAINTY: A TRIBUTE TO D.V. LINDLEY 159, 169 (P. R. Freeman and A. F. M. Smith eds., 1994) ("[T]he presumption of innocence [means that]…before any evidence is adduced, we should treat the accused as exchangeable with all other members of the population."); *but see* Redmayne, *infra* note 21, at 27 (citing Piers Rawling, *Reasonable Doubt and the Presumption of Innocence: The Case of the Bayesian Juror*, 18 TOPOI 117 (1999)) (arguing that the random selection approach precludes the possibility of a conviction but that, if jurors can "trust the police" to bring to trial only a group of people who share both some trait and a small prior probability of guilt, proof beyond a reasonable doubt can be attained).

[19] Richard D. Friedman, *Probability and Proof in* State v. Skipper*: An Internet Exchange*, 35 JURIMETRICS J. 277, 296.; *cf.* Freidman, *supra* note 16.

[20] Richard D. Friedman, *Answering the Bayesioskeptial Challenge*, 1 INT'L J. EVIDENCE & PROOF 276, 285 (1997) ("[The equally likely] test only touches on the identity element of the claim or charge. The defendant may not concede that any crime or other wrong was committed at all, and unless he does so the claimant has the burden of production on that issue as well").

themselves, considered evidence of guilt. The generic argument that leads to the defense fallacy is based on considerations that are *prima facie* inconsistent with the concept of the Presumption of Innocence. When it is explicitly argued, "The great majority of people with the relevant blood type are not suspects in the case at hand,"[21] the incongruence is intractable. Even a favorable reading of this argument fails to reconcile its incongruence.

Suppose we assume this argument is not meant to refer to the actual trial per se, but rather to the notion that since the defendant is on trial, there is probably other evidence to inculpate this particular defendant. This reading of the argument is also incongruent with the presumption of innocence. In the words of the *Coffin* Court, "Guilt or innocence is to be determined solely on evidence adduced at trial," not merely on the expectation of such evidence.[22] Although common sense dictates that people are not randomly selected for trial and that there is usually good reason (i.e. evidence) to suspect a particular defendant, this logic is antithetical to the presumption of innocence.

Equity considerations aside, using the fact of trial as evidence of guilt serves to double count evidence.[23] If it is assumed that defendants are not randomly selected to be put on trial and the reasons underlying the suspicion of the authorities are presented as evidence, such evidence would be counted twice—both when the evidence was assumed to exist and again when the evidence was presented. Moreover, such a line of reasoning would ultimately require the defendant to disprove the possibility of other evidence that arises from being on trial, which effectively places the burden of production on the defendant. But the converse is also problematic: Suppose the initial reasons that led the police to suspect a particular person

[21] Thompson and Schumann, *supra* note 4, at 171, 173. It is worth noting that in experiment 1, subjects were explicitly encouraged to consider the arrest when contriving a value (prior odds of guilt) that represents the presumption of innocence ("At this point [after receiving only preliminary information about the arrest of a suspect], subjects made an initial estimate of the probability of the suspect's guilt based only on the information they had received to that point.") In experiment 2, subjects were given a hypothetical case that focused on a detective updating his beliefs of guilt throughout an investigation. The subjects were told how the detective viewed the suspect in terms of guilt before any evidence was adduced, and were asked how the detective should update his beliefs guilt in lieu of additional evidence. This approach allowed the experimenters to specify a prior so to disambiguate the results from the first experiment. Technically, the example given is not specific to a trial though it could readably be analogized to one, and is treated as such. The Presumption of Innocence prescription could be specific to the context. *See, e.g.*, Mike Redmayne, *Appeals to Reason*, 65 MOD. L. REV. 19 (2002) (noting that the police have a different presumption of innocence than a juror).

[22] The Court refers to 9 JOHN HENRY WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW 530 (Little, Brown & Company 1981) ("[Jury is] to consider, in material for their belief, nothing but the evidence, i.e., no surmises based on the present situation of the accused".).

[23] David J. Balding, *The DNA Database Search Controversy*, 58 BIOMETRICS 241 (2004).

are illegitimate or altogether inadmissible evidence at trial.[24] The absence of such evidence could engender speculation as to why the authorities focused on the defendant in the first place. Simply put, this line of reasoning encourages jurors to consider inadmissible or even nonexistent evidence. However, jurors are to make adjudicative determinations on the basis of the evidence presented at trial, not on speculation or conjecture of how or why the defendant is currently before the court.

Even if jurors descriptively violate the Presumption of Innocence,[25] this is not a justificatory argument for doing so nor does it legitimize the *prima facie* incongruous reasoning. The argument that the other members of the narrowed suspect class are not on trial is coherent but normatively inapposite to the Presumption of Innocence. This reasoning can be reduced to the encouragement of jurors to consider inadmissible evidence. If conventional investigative techniques yielded evidence that led to the indictment of the defendant, such evidence should be presented at trial—but if it is not, such evidence should not be speculated to exist.

III. SUFFICIENCY VS. ADMISSIBILITY

Despite the intuition that the substantive argument is a mere formalism, the language of the Defense Attorney's argument is ambiguous and confusing in purpose. Refining the argument can be achieved by clearly distinguishing between the concepts of relevance and sufficiency, which makes clear the conditions under which the defense argument is misguided. This clarification has potential implications for all forms of forensic match evidence.

Under the Federal Rules of Evidence (FRE) rule 401, relevant evidence is defined as "evidence that has any tendency to make the existence of a fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence."[26] Under FRE 401, the court adopts a "broad admissibility standard," requiring evidence only to be logically relevant—not legally relevant—for it to be admissible. The determination of relevancy (and hence admissibility) is a matter for the court, requiring the court to use its own experience and judgment to assess whether a logical relationship exists

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[24] *See, e.g.*, Simon A. Cole and Michael Lynch, *The Social and legal Construction of Suspects*, 2 ANN. REV. L. & SOC. SCI. 39 (2006); Michael McConville, Andrew Sanders and Roger Leng, THE CASE FOR THE PROSECUTION: POLICE SUSPECTS AND THE CONSTRUCTION OF CRIMINALITY (Taylor & Francis, Inc. 1991) (describing how suspect populations are often targeted by the police because of their race, class or public visibility); *cf.* Redmayne, *supra* note 21.

[25] *E.g.*, Jane Goodman, *Jurors' Comprehension and Assessment of Probabilistic Evidence*, 16 AM. J. TRIAL ADVOC. 361 (1992).

[26] *See* Christopher B. Mueller and Laird C. Kirkpatrick, EVIDENCE (3rd ed. 2003); Richard O. Lempert, *Modeling Relevance*, 75 MICH. L. REV.1021 (1977).

between proffered evidence and the fact to be proven.[27] So long as the evidence makes a determination of the fact more or less likely, it is relevant and presumptively admissible. It is important to note that the piece of evidence does not have to conclusively establish the proposition in order to be relevant; the extent to which the proposition is established, or how much weight is ascribed to the evidence, is referred to probative value. Probative value speaks to sufficiency and is an entirely different concept from relevancy.[28] Relevancy is primarily concerned with whether the evidence makes the fact more or less likely, the notion being that all the evidence can be used as a mosaic to establish the proposition. As Professor McCormick observes, "a brick is not a wall."[29]

Sufficiency can be conceptualized as the extent to which a party has produced evidence to satisfy a reasonable juror that an expert's opinion is correct.[30] Where the primary concern of admissibility is whether the evidence is reliable and based on sound methods or procedures, sufficiency is concerned with evaluating whether the conclusion or inference is correct. Hence, admissibility must precede sufficiency, but admissibility does not give weight to sufficiency.[31] A possible result, therefore, of this distinction is that a piece of evidence could be admissible (when relevant) and even highly probative, but still insufficient to establish the guilt of a particular defendant.

Notice that in the generic defense argument there is not additional evidence to inculpate a particular suspect. At the time Thompson and Schumann conducted their study, the possibility of a forensic match without other inculpatory evidence (or at least some police suspicion) was wholly implausible. In recent decades, however, there has been a proliferation of DNA and fingerprint databases,[32] thus creating the

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[27] *Id*. § 4.3

[28] *See, e.g.*, State v. Irebaria 55 Haw. 353, 356 (1974) ("[T]he concept of relevance does not encompass standards of sufficiency."); People v. Martinez 74 P.3d 316, 322 (2007) ("[The] standard of admissibility is relevance and reliability, not certainty.").

[29] MCCORMICK ON EVIDENCE, (John W. Strong ed., West Publishing Company 5th ed. 1999) (McCormick's famous formulation: "An item of evidence, being but a single link in the chain of proof, need not prove conclusively the proposition for which it is offered.... It is enough if the item could reasonably show that a fact is slightly more probable than it would appear without that evidence…a brick is not a wall.")

[30] Bowers v. N. Telecom, Inc., 905 F. Supp. 1004 (1995); *see* Clewis v. State 922 S.W.2d 126 (Tex.Cr.App.1996) (discussing sufficiency standards). Sufficiency of proof is not directly alluded to in the FRE because sufficiency is determined by the standard of proof, which varies between different applications.

[31] FED. R. EVID. 401 advisory committee's notes (nothing that an item's relevance does not necessarily render it sufficient to prove some consequence).

[32] D. J. Werrett, *The National DNA Database*, 88 FORENSIC SCI. INT'L 33 (1997); *see, e.g.*, FBI, CODIS—NDIS STATISTICS (2010), http://www.fbi.gov/hq/lab/codis/clickmap.htm. (Containing over 8 million offender profiles as of May 11, 2010).

possibility that a forensic match could arise through database trawling.[33] Database trawling refers to a forensic sample being run through a database without a particular suspect in mind[34] in the hope of obtaining a "cold hit match."[35] After a database trawl produces a match, subsequent investigation will either yield additional inculpatory evidence or it will not. There have been cases brought to trial in which the sole evidence is a forensic match that resulted from a trawl.[36]

Returning to the generic example, the extent to which the match evidence can narrow the potential suspects is 1 percent of the city population, or 10,000 people, assuming this is the correct reference class.[37] On the basis of this evidence alone, the appropriate interpretation of this evidence is that the defendant and perpetrator do indeed belong to the same group. To this extent, the match evidence is, as Thompson and Schumann observe, highly probative[38] because it increases the likelihood of the defendant's guilt by narrowing the class of suspects from everyone to a group of 10,000. The associative evidence alone, however, cannot specify which of the 10,000 persons is the perpetrator. But notice that this inference is exactly what is argued by the defense attorney: "A one-in-[10],000 chance of guilt…has very little relevance for proving *this* suspect is guilty." [39] The notion of relevance, as used in the defense argument,

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[33] DNA is subsumed under the locution "forensic match evidence". There are, of course, other forms of forensic match evidence; however, most neglect to quantify the diagnosticity of the match. Therefore, I shall use DNA as the primary exemplar throughout. RICHARD SAFERSTEIN: CRIMINALISTICS: AN INTRODUCTION TO FORENSIC SCIENCE (1991);. *See also* MIKE REDMAYNE. EXPERT EVIDENCE AND CRIMINAL JUSTICE (2001) (discussing problems associated with fingerprint databases).

[34] At least not only a single suspect in mind. The authorities might suspect a pool of individuals and decide to test crime scene sample against the pool of suspected individuals. In a sense, this is still a trawl, albeit not of a database, since the authorities are testing numerous samples not just one that they suspect a priori.

[35] Peter Donnelly and Richard D. Friedman, *DNA Database Searches and the Consumption of Scientific Evidence*, 97 MICH. L. REV. 931 (1999).

[36] *See, e.g.*, Jason Felch and Maura Dolan, *DNA Matches Aren't Always a Lock*, L. A. TIMES, May 3, 2008 (describing the case of John Puckett, who was convicted of a murder that occurred thirty years prior based solely on DNA evidence).

[37] A reference class specifies the population from which the frequency is observed. *See* Jonathan J. Koehler, *When Do Courts Think Base-Rate Statistics Are Relevant?* JURIMETRICS J. 42 (2002); Determining the reference class leads to a contentious issue of what is the appropriate reference class for the defendant, since an individual belongs to an infinite number of groups. *See* PAUL E. MEEHL, CLINICAL VERSUS STATISTICAL PREDICTION: A THEORETICAL ANALYSIS AND REVIEW (1954); *see also, e.g.*, Morrow *supra* note 11, F.2d at 51 ("defendant…objects to being included in the "African-American" population of the United States since he is Jamaican by birth and does not share the population genetics characteristics of African-Americans").

[38] Thompson and Schumann, *supra* note 4 at 471.

[39] *Id.* at 177 (the vignette given to subjects; emphasis added). We shall assume for the sake of clarity in discussion that "guilt" is synonymous with factually having committed the crime. In reality, a person could have committed the act, but not be found guilty, since guilt is a legal determination that requires proof beyond the relevant threshold. Such proof might not exist, in

takes on critical import here. Clarity requires a distinction be made between the concepts of relevance and sufficiency. This distinction is best illustrated through an example of database trawling:

> Trawling a DNA database yields a cold hit match, which identifies an individual by name who has the matching genetic characteristics. Subsequent investigation yields no additional evidence that this person is the perpetrator, and the suspect denies the allegations. Nevertheless, the case goes to trial on the basis of the match evidence alone. Given the circumstances, it is misguided to conclude anything other than the defendant and perpetrator belong to the same narrowed group comprised of, say, 10,000 individuals. Even though the evidence is highly probative of guilt, it by itself cannot specify which of the 10,000 is the perpetrator. In this case, the probativeness of guilt would apply equally to all 10,000 individuals. So while this match evidence is relevant for proving guilt, it is not by itself sufficient for proving a particular defendant is guilty.

It is not incoherent to concede that a piece of evidence is relevant, yet still argue that the same piece of evidence is inconclusive.[40] The claim of a defense fallacy is based in part on a confusion of the concepts of relevance and sufficiency. It is unclear from Thompson and Schumann's generic example whether the defense attorney is arguing that the match is irrelevant to proving the guilt of a suspect or insufficient to prove the identity of the perpetrator within the class suspects—particularly given the emphasis on the word "this." Such confusion is not unique to this particular form of the argument. In another study, for example, the argument given to jurors is that "the evidence in this case is completely irrelevant because a substantial number of other people could also be the source."[41] Neither argument

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which case the person is not guilty, even though he/she committed the alleged act.

[40] Koehler, *supra* note 9 at 1283 (" it is reasonable to point to the non-uniqueness of the evidence to show it is not dispositive, it is not reasonable to dismiss the evidence as lacking any probative value"); *cf.* Kaye et al. *supra* note 3 at 811. ("if the suspect matches, then all that can be said [from the fact of the match alone] is that he is included in the class of people who might have left the DNA at the crime scene").

[41] Kaye et al., *supra* note 40 at 804. ("the [defense] fallacy occurs when, given the same RMP [random match probability] of 1 percent, the jury concludes that since only 1 percent of the population could have contributed the relevant sample and that number is say, 100 people, then the odds that the defendant supplied the DNA sample are only 1 in 100, and, therefore, that *the evidence has virtually no value in linking the defendant to the crime* (emphasis added)".) But, the DNA evidence in and of itself does not link the particular defendant any more than the other 100 people who match; *cf.* Redmayne, *supra* note 33 at 72. It is not necessarily incoherent to bolster

clearly indicates whether the evidence is useless for proving the guilt of the class of suspects, or for an individual from within that class. The former interpretation is fallacious; the latter may not be.

The fallaciousness of the defense fallacy depends on the suggestion that the forensic match evidence has no probative value and, hence, no relevance. That an attorney would proffer such an argument seems unfeasible and disingenuous[42] since, intuitively, any evidence that reduces the class of suspects is highly useful for establishing the guilt of the suspects who remain in the narrowed class. It should be noted that probative value is weighed against prejudicial impact[43] in determining admissibility, not whether the evidence is sufficient to establish a conclusion. Whether or not the evidence in the case satisfactorily proves guilt is a matter of sufficiency, a concept that necessarily follows admissibility. Therefore, it seems the defense attorney has to be (correctly) arguing sufficiency, not relevance; that is, the defense attorney is arguing the match evidence is insufficient to establish the identity of the perpetrator, not the guilt of the class of suspects. The use of the word "relevance" confuses the issue given legal parlance.

Attorneys can legitimately argue that forensic match evidence does not, and in principle cannot,[44] conclusively (or exclusively) establish the identity of the perpetrator. Even though this is commonly thought to be the defense fallacy, the example of trawling demonstrates this argument is not fallacious—forensic match evidence by its very nature is not dispositive, even though additional evidence can bridge this sufficiency gap. Since relevant evidence (evidence with any probative value) is presumptively admissible, *de facto* arguments made by practicing attorneys must be of the sufficiency type (since irrelevant evidence is inadmissible). However, even

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such an argument even with additional incriminating evidence. *See infra* notes 53-62 and accompanying text.

[42] Roger Park, *Probability and Proof In State v. Skipper: An Internet Exchange*, 35 JURIMETICS J. 277, 287 (1995), (calling the defense fallacy a "laughable argument, you wouldn't expect to be made." And that using common sense, "it is overwhelming evidence of guilt."); *but see* Thompson and Schumann, *supra* note 4 at 183 (noting that over 60% of subjects were persuaded to believe the associate evidence deserved no weight); *cf.* Kaye et al., *supra* note 3 at 813 (finding that 40% agreed with the defense fallacy argument, which is claimed to be "larger than previous reports of the incidence of the fallacy"); *but see also* Smith et al., *supra* note 3 (finding that a substantial number of jurors did not succumb to either fallacy; also discusses reasons for why the methodology used by Thompson and Schumann could account for such high incidence rates of this fallacy).

[43] FED.R. EVID. 403 ("although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative evidence").

[44] The infrequency of rarity of a match statistic should not be equated to uniqueness. *See* Michael J. Saks and Jonathan J. Koehler, *The Individualization Fallacy in Forensic Science Evidence*, 61 VA. L. REV. 199, (2008).

when it is clear that a sufficiency argument is being made, the fallaciousness of the defense argument is contingent on the existence of other evidence that is indicative of guilt.

IV. THE WEIGHT OF EVIDENCE OR THE WEIGHT OF GUILT

So far the paper has principally shown that if (a) there is a forensic match and (b) the only evidence is that a defendant has been charged with a crime, then it is not fallacious to argue the evidence is insufficient to establish the identity of the perpetrator as the defendant. A visceral reaction is that there must be additional evidence to substantiate guilt, for it is unlikely a case would ever get to trial on the basis of match evidence alone. As noted, there have been cases brought to trial on the basis of DNA evidence alone,[45] especially since DNA evidence is now putatively capable of producing chance match probabilities on the order of hundred billions and quintillions. With coincidental matches putatively this unlikely—numbers that far exceed the population of the earth—the virtual certainty of the match is assumed,[46] and such cases do make their way to trial without additional evidence. But this section sets aside these cases to consider perhaps the more common, and seemingly more damaging, situation in which there is a forensic match and other additional evidence. In so doing, this section demonstrates that the defense attorney argument, if properly understood to be a sufficiency (or insufficiency) argument, is not necessarily fallacious, even with evidence in addition to a forensic match.

Read in one light, the defense argument could simply be that the appropriate weight (probative value) to ascribe to the match evidence derives solely from the fact that it narrowed the class of suspects, and that this weight is independent of additional evidence. In other words, while additional evidence would increase overall sufficiency (i.e. the actual quantity of evidence pertaining to guilt), it would not change the probativeness of the match evidence. For example, suppose in addition to the DNA matching evidence, the only other evidence is that the defendant fits a specific eyewitness description exclusive to him. The fact that he fits the eyewitness description does not increase the weight ascribed to the DNA matching evidence,[47] assuming the DNA evidence is conditionally

[45] Felch and Dolan, *supra* note 36.

[46] The notion that forensic evidence is capable, in principle, of producing matches that are unique to the exclusion of all others appears to be pervasive amongst lawyers, judges and jurors alike; however this notion is simply a misconception. This phenomenon has been labeled "the uniqueness fallacy." DAVID J. BALDING, WEIGHT-OF-EVIDENCE FOR FORENSIC DNA PROFILES (2005). *See* Saks and Koehler, *supra* note 44.

[47] A likelihood ratio is a means of conceptualizing the probative weight of a piece of evidence. *See* Lempert, *supra* note 26. In Bayesian terms, what is being suggested here is that each piece of independent evidence (i.e. the DNA matching evidence and eyewitness description) is a separate

independent.[48] It does, however, substantially increase the likelihood that the defendant is the perpetrator.[49]

This implicates two separable issues with respect to the defense argument: first, what is the appropriate scope of an interpretative argument of forensic match evidence; and second, what is the value of forensic match evidence in light of additional evidence.

A. The Scope of Interpretative Arguments of Match Evidence

The generic argument suggests that a "1-in-10,000 chance of guilt" is fallacious because the other members of the narrowed class are not on trial. This reasoning is rational but normatively inapposite because it implies the trial is evidence of guilt. A derivative of this argument is to say that a "1-in-10,000 chance of guilt" is fallacious because it ignores other evidence that is indicative of guilt. Although not necessarily incorrect, this type of reasoning extends the function of forensic match evidence beyond its intrinsic ability and potentially misrepresents the value of the match evidence.

The proposition relevant to match evidence, hence an interpretative argument of the evidence, is whether a given person is the source of the crime scene sample, not whether the source of the crime scene sample is guilty of an alleged crime.[50] Forensic match evidence is impotent to the latter deduction because it would require an expert to speculate on the strength of the other evidence, and to make a determination that invades the province of the jury.[51] Forensic match evidence may be able to

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likelihood ratio. The quantification of each likelihood ratio is independent of one another. So additional pieces of independent evidence do not affect the magnitude of a likelihood ratio, but create more likelihood ratios. *See also* David A. Schum and Anne Martin, *Formal And Empirical Research on Cascaded Inference in Jurisprudence*, 17 L. & SOC. REV. 1 (1982).

[48] Richard O. Lempert, *Of Flutes, Oboes and the As If World*, 1 INT'L J. EVIDENCE & PROOF 5, 318 (1997) ("The probability of a DNA match which is given to the jury is usually conditionally independent of the other evidence in the case, since it is the probability that a random person would have DNA matching the evidence sample and not the probability that the defendant would have matching DNA.")

[49] WILLIAM M. BOLSTAD, INTRODUCTION TO BAYESIAN STATISTICS (2004) (noting that multiple informative likelihood ratios would be consequential for the posterior probability). I will set aside issues originating from the classic caveat of Bayesian analysis, which is that Bayes presupposes no ordering effect. *See e.g.*, DAVID V. LINDLEY, BAYESIAN STATISTICS: A REVIEW 2 (1970) (i.e. "today's posterior is tomorrow's prior.")

[50] Donnelly and Friedman, *supra* note 35.

[51] The expert should convey the diagnosticity of the match evidence independent of personal beliefs (i.e. a subjective prior) because personal beliefs are beyond the scope of expertise. *See generally* Willem Wagenarr, *The Proper Seat: A Bayesian Discussion of the Position of Expert Witnesses*, 12 L. & HUMAN BEH. 4 (1988). Another argument against the inclusion of a 'prior' on behalf of an expert is that there is not a meaningful way to operationalize the reference class. Redmayne, *supra* note 33 at 47-8. Moreover, this brings the order of presentation into question, since additional evidence presented before the forensic match evidence would have to be

substantially narrow the class of potential suspects—and additional evidence may be able to specify the perpetrator from within this narrowed class—but the correct inference from the match evidence is that it *narrowed* the class of suspects, not that it *specified* the perpetrator from within the class. In principle, the two functions are different. Drawing an analogy to McCormick's famous formulation,[52] each piece of evidence is a link in the chain of proof; the "link" that is provided by the match evidence should not argued as the "chain."

B. The Value of Match Evidence in Light of Additional Evidence

If considered a conditionally independent piece of evidence, the probative value of a forensic match should not change depending on additional evidence, from which it follows that an interpretative argument of the match evidence need not change depending existence of additional evidence. To some extent this general deduction has been implicated in the highly contentious DNA database controversy.[53]

The controversy hinges on the extent to which the probative value of a DNA match differs if, for example, it leads to an eyewitness identification, rather than the eyewitness identification leading to the DNA match—in essence an order effect. The former could be a case of database trawling [54] in which the match subsequently leads to additional evidence, while the latter exemplifies the conventional approach of detection where evidence is gathered with a particular suspect in mind. In the case of the database trawl, numerous samples are generally tested before the match is determined, whereas in the conventional approach only one sample is tested. The vexing issue is the extent to which the probative value of the match should be adjusted to account for multiple tests.

Peter Donnelly and Richard Friedman[55] compellingly argue that the number of tests does not affect the probative value of the forensic match evidence but that it could affect the sufficiency of the entire case: "It is not that the DNA evidence is weakened…it is possible that the *other* evidence in the case is weaker by virtue of the fact that identification from a database trawl has [led] to it."[56] In other words, the probative value of the match does not change, but the match might change the sufficiency

accounted for in such a prior. Lindley, *supra* note 49; *but see* Meester and Sjerps *infra* note 53, arguing that posteriors should be used to present DNA evidence, which includes a prior.

[52] McCormick, *supra* note 29.

[53] *But see* Ronald Meester and Marjan Sjerps, *The Evidential Value in the DNA Database Search Controversy and the Two Stain Problem*, 59 BIOMETRICS 727 (2003) (calling this "a false controversy").

[54] Again, it is possible that an eyewitness identification led to numerous suspects being tested, rather than a single suspect, which would typically be regarded as a trawl. *See supra* note 34.

[55] Donnelly and Friedman, *supra* note 35.

[56] *Id.* at 958-60. The authors note two ways by which trawling reduces the sufficiency of the case

of the case. This line of reasoning suggests that it might not be inappropriate to assess the weight of the DNA evidence in isolation, because additional evidence does not affect the weight of the matching evidence—it affects the overall sufficiency of the case. Hence, in the generic example, it is not fallacious to argue that the probativeness of the match evidence alone is on the order of 1 in 10,000 in whatever form this is to be presented,[57] even if there is additional evidence.

The validity of this probative invariance relies on the conditional independence of the forensic match evidence. Evidence that is conditionally independent is generally neither redundant nor cumulative,[58] where ascertainment of one piece of evidence does not change the perceived value of the other piece. Generally, DNA evidence is conditionally independent of other evidence, since it is typically conveyed as the probability that a random person, not necessarily the defendant, would match.[59] But ironically, DNA evidence is uniquely independent.[60] In cases of conditional non-independence, the value of the evidence must be adjusted to take into account the conditional dependency; otherwise the evidentiary value of each individual piece of evidence would be inflated or double-counted.[61]

In cases of conditionally independent evidence, the probative value of that evidence is the same regardless of the other evidence in the case. Given this premise, the argument of a "1-in-10,000 chance of guilt" is valid to the extent it refers to the match evidence, not the case in chief, which is the appropriate scope of forensic match evidence. However, in the case of

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in chief. By definition there is additional evidence in a non-trawl case before the match is made, which is not true for the trawl case and may not be true after the match is made. It could also be the case that the evidence discovered after the trawl match is "tainted by suggestiveness." It is possible, however, that the a priori suspicion of a particular suspect could "taint" the forensic match, given that most forensic evidence labs work closely with the authorities. This is sometimes referred to as "observer effects." *See* D. Michael Risinger et al., *The Daubert/Khumo Implications of Observer Effects in Forensic Science: Hidden Problems of Suggestions and Expectation*, 90 CAL. L. REV. 1 (2002).

[57] Jonathan J. Koehler, *On Conveying the Probative Value of DNA Evidence: Frequencies, Likelihood Ratios, and Error Rates*, 67 U. COLO. L. REV. 859 (1996).

[58] Lempert, *supra* note 26. at 1041-4.

[59] *Cf* Lempert, *supra* note 48 at 318 ("[conditional non-independence] is seldom a problem with the topic of my message, DNA evidence.") Unfortunately, the diagnosticity of other forms of forensic match evidence is typically conveyed in misleading qualitative terms. In theory this need not be the case. It is possible, and perhaps desirable, that other forms of forensic match evidence attempt to quantify the diagnosticity of a match. Developing the capability to do so would entail the development of a repository from which rarity frequency estimates can be estimated. *See* Saferstein, *supra* note 33.

[60] Richard O. Lempert, *The New Evidence Scholarship: Analyzing the Process of Proof*, 66 B. U. L. REV. 439, 452 (1986) ("the different elements of a…case are generally highly dependent.")

[61] *See* DAVID SCHUM, THE EVIDENTIAL FOUNDATIONS OF PROBABILISTIC REASONING (1994). (By and large the most comprehensive work to model the dependencies amongst evidence).

conditional non-independence, the probative value of the match evidence must be adjusted to account for the dependencies amongst the other evidence—an exceedingly arduous task. The central issue is who should make this adjustment in the case of non-independence? On one hand, it seems improper for an expert to proffer a value that is spurious because it is unadjusted, but on the other hand it is beyond the scope of the expert to assess the extent of the dependency with other evidence and make such an adjustment. This leaves two possibilities: either the expert should abstain from offering any estimate of probative value in the case where the evidence is conditionally non-independent, or the expert can offer the unadjusted estimate, but explicitly acknowledge that the value of such evidence ought to be discounted to account for the dependency.[62] Neither solution is sanguine, but the latter seems more pragmatic.

V. CONCLUSION

The defense fallacy claim implies that match evidence alone bestows additional evidence and therefore it is fallacious to conclude the defendant and perpetrator are simply part of a large group. In a rational sense this claim has some merit to it, since jurors intuitively know that defendants are not randomly selected and put on trial, and the fact that a particular defendant had been brought to trial suggests there is some plausibility to his guilt. This is sound reasoning, but this type of intrinsic additional evidence is incongruent with a fundamental tenet of the criminal trial process. Whether or not the defense fallacy is a fallacy, the particular reason underlying it is inconsistent with the Presumption of Innocence. Arguments relevant to forensic match evidence should not rely on such reasoning to bridge the sufficiency gap.

The defense fallacy argument requires clarification of the distinction between the concepts of relevance and sufficiency. Forensic match evidence is in itself useful for proving guilt of the entire class of suspects, but not necessarily for proving the identity of the perpetrator from within the narrowed class of suspects. The former conception is a relevance argument; the latter is a sufficiency argument. Commentators should be cognizant of the fact that forensic match evidence (and, in fact, virtually all forms of evidence) are not dispositive. A consequence is that it is not misguided for an attorney to

[62] This is a suggestion warrants empirical attention. The extent to which jurors are able to discount for dependencies is not well known and has received very little attention within the literature. For a notable exception, *see* Lisa E. Hasel and Saul M. Kassin, *On the Presumption of Evidentiary Independence: Can Confessions Corrupt Eyewitness Testimony?*, 20 PSYCH. SCI. 122, (2009).

point out that match evidence is insufficient[63] to establish the identity of the perpetrator as the defendant. Of equal importance, commentators should be cautious in labeling sufficiency arguments as fallacious.

One tenable means of bridging the sufficiency gap is the use of additional evidence. While the forensic match evidence might narrow the class of suspects, additional evidence might be able to identify the perpetrator from within the class. It is important to keep in mind that—in principle—interpretative arguments speak to the match evidence, not the cumulative evidence in the case. Conditional dependencies among pieces of evidence do not change this principle, though conditional dependencies do affect the probative value of the match argument. This is an important distinction, as even with additional evidence, a defense attorney can legitimately argue that the forensic match evidence is by itself insufficient.

The purpose of this paper is not to suggest that defense attorneys do not misinterpret and misrepresent forensic match evidence. No doubt erroneous interpretations are ubiquitous throughout jurisprudence and are regularly proffered by the defense, the prosecutor, and perhaps most egregiously by experts. The empirical research, especially that of Thompson and Schumann, has been influential in helping the courts recognize and disabuse the errors that inherently result from this convoluted subject matter. This paper suggests that experts, researchers and ultimately consumers of forensic match evidence are better served by paying attention to the distinction between sufficiency and relevance.

[63] This postulate depends to some extent on the relevant standard of proof. It is conceivable that forensic match evidence is capable of establishing the requisite facts under a lax standard of proof, such as the preponderance of evidence. It is also true that the reasonable doubt standard does not require fact finders to have absolute certainty in order to convict. If a forensic match is capable narrowing the class of suspects beyond a fact finder's subjective threshold for reasonable doubt, then it is theoretically possible that the match evidence is sufficient, even though match evidence cannot ever attain absolute certainty in the dispositive sense. Such proof could be regarded as naked statistical evidence, which courts and fact-finders have been historically reluctant to convict upon. See Jonathan J. Koehler and Daniel N. Shaviro, *Veridical verdicts: Increasing verdict Accuracy Through the Use of Overtly Probabilistic Evidence and Methods*, 75 CORNELL L. REV. 247 (1990); Gary L. Wells, *Naked Statistical Evidence: Is Subjective Probability Enough?* 62, J. PERSONALITY & SOC. PSYC. 739 (1992).