PROBATIVE INFERENCE FROM PHENOMENAL COINCIDENCE: DEMYSTIFYING THE DOCTRINE OF CHANCES[1][2]

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The doctrine of chances remains a divisive rule in the law of evidence. Proponents of the doctrine argue that evidence of multiple unlikely events of a similar nature supports an objective, statistical inference of lack of accident or random chance on a particular occasion. Opponents argue that admissibility is improper because the underlying inference ultimately requires a forbidden form of character or propensity reasoning. Using formal probability modeling and simple numerical examples, this paper shows that neither side is correct. Contrary to the claims of its proponents, the doctrine of chances provides no novel or independent theory of relevance. But contrary to the claims of its opponents, the doctrine-of-chances inference does not require character or propensity reasoning. An intuitive way to understand these properties is to interpret the doctrine-of-chances inference as a weak form of any inference that could be permissibly drawn if extrinsic events were simply bad acts for which culpability or intent were certain.

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[2] This paper has greatly benefitted from the thoughtful comments of Darryl Brown, as well as many participants of the 2013 annual meeting of the American Law and Economics Association.
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1 INTRODUCTION

Over the past twenty years, a microcosm of scholarly commentary on the doctrine of chances has consumed much paper but yielded little consensus. The unlikely subject of scrutiny is a narrow and seemingly sensible affordance in the law of evidence allowing repeated realizations of an improbable event to be considered evidence against the possibility of innocent accident or random chance. Put another way, the doctrine of chances codifies the commonsense intuition that the poker player who draws too many aces is probably cheating.

Despite its apparently commonsense appeal, the jurisprudential validity of the doctrine of chances has been murky for quite some time now. Debate mainly concerns the chain of inference upon which relevance of the unlikely-event evidence is based. Proponents of the doctrine of chances argue that evidence of multiple unlikely events of a similar nature supports an objective, statistical inference of lack of accident or random chance on a particular occasion: i.e. an inference of purposive action or intent. Opponents of the doctrine argue that the case for admissibility fails under scrutiny because the critical inference ultimately requires some form of forbidden character or propensity reasoning. The literature on this topic is dense, mystifying, and in many respects badly confused.

This paper aspires to clarify at least some of the confusion in the literature by examining in detail the inferential logic supporting the doctrine of chances. A simple numerical model provides a framework for analysis, and is used to illustrate two important properties about the doctrine. First, the doctrine of chances affords no novel or independent theory of relevance; extrinsic event evidence is relevant only on an indirect basis through appeal to collateral theories of dependence. Second, the use of extrinsic event evidence under the doctrine of chances does not require character or propensity reasoning, so extrinsic event evidence may indeed be admissible in an appropriate context. Together, these two properties afford several insights into the theory and foundation of the doctrine of chances, as well as its proper interpretation and practical limitations.

The narrow topic and mode of analysis in this paper permit concise inquiry. Section 2 provides background material on the history, application, and scholarly critique of the doctrine of chances. Section 3 analyzes a simple numerical model of the doctrine-of-chances inference, demonstrating when and how the doctrine supports the admissibility of extrinsic event evidence. Section 4 comments on implications for legal practice. The paper concludes with a recap of the central argument and its principal implications.

2 BACKGROUND ON THE DOCTRINE OF CHANCES

2.1 *A Question of Admissibility*

The *doctrine of chances*, as it has come to be known, is a somewhat obscure axiom in the law of evidence providing for the admissibility of extrinsic event evidence under specific circumstances. Though the foundational applications defy concise summary, the argument for admissibility usually involves (1) an improbable event, (2) realized repeatedly, (3) for which the theory to be opposed is that either accident or random chance explains the occurrence of some subset of the events in question.[4] Under these circumstances, the doctrine of chances stands for the proposition that evidence of extrinsic events may be admissible to disprove the theory of repeated accident or random chance on the intrinsic events.

The novelty of the doctrine of chances – if any – derives from its relationship to the general common law prohibition on character evidence, codified, for example, in Federal Rule of Evidence 404(a)(1): evidence of a person's character or propensity to act in a certain way is generally inadmissible to prove action in conformity with such charac-

[4] *See generally* Edward J. Imwinkelried, *The Use of Evidence of an Accused's Uncharged Misconduct to Prove Mens Rea: The Doctrines Which Threaten to Engulf the Character Evidence Prohibition*, 51 OHIO ST. L.J. 575, 589–93 (1990) (suggesting circumstances under which the doctrine of chances may be invoked); 1 JOHN HENRY WIGMORE, A TREATISE ON THE ANGLO-AMERICAN SYSTEM OF EVIDENCE IN TRIALS AT COMMON LAW INCLUDING THE STATUTES AND JUDICIAL DECISIONS OF ALL JURISDICTIONS OF THE UNITED STATES AND CANADA § 302 at 612–16 (2d ed. 1923) (providing historic context and highlighting example caselaw).

ter or propensity on a particular occasion.[5] On the force of this prohibition, evidence of extrinsic events (i.e. other crimes, uncharged offenses, or bad acts) is *a fortiori* inadmissible if proffered to show a person's character or propensity-to-act in support of the further inference that the person acted in conformity with such character or propensity on a particular occasion.[6] The operative prohibition is not on the use of extrinsic event evidence itself, but on the use of such evidence for what may be described in short-hand as *character* or *propensity reasoning*. Other uses of extrinsic event evidence are expressly permitted – subject, of course, to the normal admissibility hurdles of relevance,[7] substantial danger of unfair prejudice,[8] etc.

Problematically, courts and commentators have made little progress in charting the exact boundaries of character and propensity reasoning, and it can be difficult to say whether a given inference is or is not forbidden under the rule. Federal Rule of Evidence 404(b)(2) collects some recognized common law touchstones of *non-character* and *non-propensity* reasoning in its suggestion that extrinsic event evidence may be admissible to prove "motive, opportunity, intent, preparation, plan, knowledge, identity, absence of mistake, or lack of accident,"[9] but even these examples have been attacked by some as ultimately indistinguishable from character or propensity reasoning.[10]

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[5] FED. R. EVID. 404(a)(1). *See generally* 1 MCCORMICK ON EVIDENCE §§ 186, 188 (Kenneth Broun ed., 7th ed. 2013); McKinney v. Rees, 993 F.2d 1378, 1380–81, 1381 n.2 (9th Cir. 1993) (commenting on the legacy of this rule and its wide application throughout United States jurisdictions). The equation of "propensity" reasoning with "character" reasoning is common, if unprincipled. *See* Richard B. Kuhns, *The Propensity to Misunderstand the Character of Specific Acts Evidence*, 66 IOWA L. REV. 777 (1981) (distinguishing "character" reasoning from "propensity" reasoning).

[6] *E.g.* FED. R. EVID. 404(b)(1).

[7] *E.g.* FED. R. EVID. 401, 402.

[8] *E.g.* FED. R. EVID. 403.

[9] FED. R. EVID. 404(b)(2).

[10] *See* Paul F. Rothstein, *Intellectual Coherence in an Evidence Code*, 28 LOY. L.A. L. REV. 1259, 1260 (1995) (refuting any practical separation between the permitted and prohibited inferences in Rule 404(b)); *cf.* Kuhns, *supra* note 5, at 797–98 (arguing that neither the term "character" nor "propensity" adequately describes the bounds of what is and isn't a permissible use of extrinsic event evidence).

Against this backdrop, proponents of the doctrine of chances claim that it represents a distinct non-character/non-propensity theory of relevance in which evidence of extrinsic events rebuts the theory that accident or random chance explains the events in question by appeal to the objective improbability of such an explanation.[11] This very argument helps to explain the inclusion of "absence of mistake, or lack of accident" in the 404(b)(2) list of non-character/non-propensity inferences.[12] But exactly how the doctrine-of-chances inference differs from forbidden character or propensity reasoning is far from clear, and has become a topic of rather polarizing debate among evidence scholars. The remainder of this paper aims to shore up at least part of the confusion in the literature by examining in detail the inferential logic that supports the doctrine of chances. Throughout the process, a running example helps to frame analysis.

2.2 *A Running Example: The Brides in the Bath Case*

The leading illustration of the doctrine of chances in United States casebooks is the old and sensational English-law case of *Rex v. Smith*, better known as the *Brides in the Bath* case.[13] The facts and issues at bar in this case are – for better or worse – mainly recounted in a series of newspaper articles and popular-culture books that monitored with fascination with the plight of George Joseph Smith as his case wound its way through the English court system *circa* World War I. Recognizing that contemporary descriptions of *Rex v. Smith* are often inaccurate, incomplete, or both, a brief review of the relevant posture, facts, and issues is warranted.

On February 2, 1915, George Joseph Smith was charged in Police Court with having entered a false marriage record between himself (under the name "John Loyd") and his by then decedent-wife, Margret

[11] *See, e.g.*, Edward J. Imwinkelried, *An Evidentiary Paradox: Defending the Character Evidence Prohibition by Upholding A Non-Character Theory of Logical Relevance, the Doctrine of Chances*, 40 U. RICH. L. REV. 419, 435 (2006).
[12] *See* MCCORMICK ON EVIDENCE, *supra* note 5, at § 190(3).
[13] Rex v. Smith, *aff'd* 11 Cr. App. R. 229, 84 L.J.K.B. 2153 (1915).

Elizabeth Lofty.[14] Ms. Lofty had been found drowned in her bathtub on December 17, 1914, and the context for the charge was the discovery that Smith's previous marriage to Alice Burnham (this time as "George Smith") had ended in a conspicuously similar bathtub drowning on December 12, 1913.[15] Facts mounted against Smith, who was ultimately charged with the murder of both women, as well as that of a third wife, Bessie Constance Annie Mundy (married to Smith under the name of "Henry Williams"), who had been discovered drowned in her bathtub on July 13, 1912.[16]

The particular vector of demise was not the only similarity between these three incidents. In even minor details, each marriage and bathtub drowning was eerily similar. As the facts would eventually be summarized in court,

> (1) In each case there was a death in a bath, and in each case [Smith] had moved to that bathroom or fitted it up within a week before the death. (2) In each case the bathroom in which the death took place was unlocked, so that [Smith] could go into it ... (3) In each case the dead woman made her will in favour of [Smith] within a week before her death. (4) [In each case Smith stood to gain additional insurance proceeds or property from the woman's death]. (5) In each case all the debts due to the dead women and all savings bank accounts had been realized just before the

[14] *Bride's Death in a Bath. Police Court Tale of Two Marriages: A "Phenomenal Coincidence,"* TIMES (London), February 3, 1915, at 5.
[15] *Bride's Death in a Bath. The Marriage Register: Accused Man's History*, TIMES (London), February 9, 1915, at 5. The date of Ms. Burnham's death is sometimes cited as the 13th. *See, e.g.*, *supra* note 14.
[16] *Brides Drowned in Baths. Three Charges of Murder: An Extraordinary Story*, TIMES (London), March 24, 1915, at 4. In reports of the time, Bessie's surname is variously spelled as either "Munday," *e.g. id.*, or "Mundy," *e.g.* TRIAL OF GEORGE JOSEPH SMITH 6 (Eric R. Watson, ed., 1922). This paper adopts the latter convention, which appears the more common and better-informed alternative.

> death. … (12) In each case [Smith] buried [the body] as quickly and cheaply as possible.[17]

An additional commonality was that each wife's drowning was initially ruled an accident – the result of the decedent fainting, slipping, or being overtaken by fit while bathing.[18] Smith stuck to this theory throughout, disclaiming each drowning as the unfortunate product of chance. Speaking before Ms. Mundy's drowning had yet been discovered, for example, Smith averred, "I admit the two deaths form a phenomenal coincidence, but that is my hard luck. You may think it strange, but it was the irony of fate that my two wives died in that way."[19]

All indictments against Smith were eventually removed to the Central Criminal Court,[20] but for reasons unclear in the reports, Smith was only tried before the Criminal Court on the murder of his first wife, Ms. Mundy.[21] On the isolated facts of the Mundy drowning alone, it is generally agreed that Smith would not have been convicted.[22] The

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[17] *Brides in Baths. Prisoner Sentenced to Death: The Closing Scenes*, TIMES (London), July 2, 1915, at 4.

[18] *See, e.g.*, *The Drowned Brides. Medical Evidence on Epilepsy: Herne Bay Doctor Cross-Examined*, TIMES (London), April 17, 1915, at 4.

[19] *The Brides Case. Prisoner On Trial at the Old Bailey: The Death of Miss Mundy*, TIMES (London), June 23, 1915, at 5.

[20] *King's Bench Division. The Drowned Brides Case: Re George Joseph Smith*, TIMES (London), May 21, 1915, at 3.

[21] *See, e.g.*, *The "Brides" Case. Recorder's Charge to the Grand Jury*, TIMES (London), June 16, 1915, at 5 ("The duty of the grand jury in this Court was limited to considering the evidence so far as it affected the Mundy case, although it had been thought necessary and desirable in the interest of public justice that all the indictments should be removed by *certiorari* into this Court."); *supra* note 19 ("There were other charges against Smith, but the only one proceeded with yesterday was that of murdering Miss Mundy."). Smith's marriage to Bessie Mundy was temporally first among the three wives who drowned in their baths. There were actually at least seven wives total, of which Ms. Mundy was the third. *See, e.g.*, *Brides in Baths. Prisoner Sentenced to Death: The Closing Scenes*, *supra* note 17; *Trial of George Joseph Smith*, *supra* note 16, at 1–33.

[22] 33 THE CANADIAN LAW TIMES 853 (Edward Douglas Armour, et al., eds., 1915) (stating that "there is no doubt" Smith would not have been convicted on the facts of Ms. Mundy's death alone) (quoting SOLICITOR'S JOURNAL AND WEEKLY REPORTER for August 21st of 1915); *The Brides Case. Mr. Bodkin's Array of Coincidences:*

importance – and controversy – of *Rex v. Smith* lies in the prosecution's proposal to enter evidence at trial of the similar circumstances and drowning deaths of Smith's subsequent wives, Ms. Burnham and Ms. Lofty.[23]

Ruling on challenge to the admissibility of this extrinsic event evidence, Justice Scrutton (overseeing the Smith case in Criminal Court) admitted the Burnham and Lofty evidence subject to a limiting instruction that barred the jury from engaging in character or propensity reasoning. The jury was instructed that it could not use the evidence to reason that Smith "is a man of bad character, and therefore is very likely to have murdered Miss Mundy."[24] In greater elaboration, the Justice explained,

> It is not competent for the prosecution to adduce evidence tending to show that the accused has been guilty of criminal acts other than those covered by the indictment *for the purpose of leading to the conclusion that the accused is a person likely from his criminal conduct or character to have committed the offence with which he is charged*.[25]

The jury was instructed that it could, however, consider the Burnham and Lofty evidence in drawing its own inference "whether the death of Miss Mundy was by accident or design … whether [Smith] had a system of obtaining money from women by going through the form of

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Speech for the Defence, TIMES (London), July 1, 1915, at 4 (crediting Smith's counsel as arguing "The calling of evidence in the other two cases impliedly proved that the evidence in that of Miss Mundy was not conclusive."). To put the apparent evidence in perspective, it should be recalled that every inquest following the drowning of a wife resulted in a verdict of accident or misadventure. *See, e.g.*, *Trial of George Joseph Smith*, *supra* note 16, at 13, 19, 26.

[23] *See The Brides Case. Prisoner On Trial at the Old Bailey: The Death of Miss Mundy*, *supra* note 19.

[24] *Id.*

[25] *Brides in Baths. Prisoner Sentenced to Death: The Closing Scenes*, *supra* note 17 (emphasis added).

marriage with them and then murdering them."[26] The jury was reminded that Smith was only on trial for the murder of his first wife, Ms. Mundy, and that use of the Burnham and Lofty evidence should be limited to considering the plausibility of the defense's theory of accident in relation to the Mundy drowning alone.[27]

If the isolated facts of Ms. Mundy's drowning would indeed have been insufficient to convict, then entrance of the Burnham and Lofty evidence served its purpose: the jury found Smith guilty after only 18 minutes of deliberation.[28] While few would venture to say that Smith was innocent of wrongdoing,[29] several details of the application of law in *Rex v. Smith* render the case a controversial one.

For example, in instructing the jury on what might be inferred from the circumstances and bathtub drowning deaths of Ms. Burnham and Ms. Lofty, Justice Scrutton gave the example of a card-player discovered to have an ace concealed in his pocket:

> [C]ards had a way of falling about, and perhaps on an isolated case [the other players] would not form a definite opinion. Supposing, however, they hear that on several other occasions the ace of trumps had been found in that man's pocket *they would draw from that series of fortunate accidents the inference of design*. The matter depended on the unusualness of the occurrence and the number of

[26] *Id.; see also The Brides Case. Mr. Bodkin's Array of Coincidences: Speech for the Defence*, *supra* note 22 ("The jury were entitled to look at the evidence as to the two other deaths to see whether the death of Miss Mundy was accident or designed.").
[27] *Brides in Baths. Prisoner Sentenced to Death: The Closing Scenes*, *supra* note 17.
[28] *Death Sentence in Brides Case. Prisoner's Protests*, TIMES (London), July 2, 1915, at 8.
[29] Many of the more sordid and sensational details of George Smith's conduct have been omitted from this brief summary of the facts. Suffice it to say that allegations against Smith indicated a consistent, and frankly shocking, pattern of exploitation and abuse of women. *See, e.g.*, *Trial of George Joseph Smith*, *supra* note 16, at 1–33 (chronicling Smith's alleged exploits in greater detail); *cf. Brides in Baths. Prisoner Sentenced to Death: The Closing Scenes*, *supra* note 17 (Justice Scrutton agreeing with the jury verdict and volunteering post-trial character evidence against Smith).

> times it was repeated. *Each additional case increased the improbability of accident*.[30]

It is unclear *which* accident the example means to disprove. Smith was tried only for the death of his first wife. Does this example suggest that the jury might infer the murder of Ms. Mundy from the subsequent drowning deaths of Ms. Burnham and Ms. Lofty, or is the inference actually the reverse – that the Mundy drowning suggests foul play in the temporally subsequent events? If not the reverse, then drawing the "inference of design" from Smith's conduct with regard to Ms. Burnham and Ms. Lofty seems to contemplate that such conduct could inform the jury's estimation of Smith's conduct on the particular occasion of the Mundy drowning, which is difficult to distinguish from the reasoning forbidden by the limiting instruction.[31]

Other details of the case engender similar concern. For example, after cautioning the jury that Smith was on trial for the murder of Ms. Mundy alone, Justice Scrutton further instructed the jury that it was for them to decide "whether that set of coincidences *in the three cases* could be the result of accident."[32] It is unclear what conclusion a negative answer to this question was intended to support. The instruction might, for example, be understood to imply that Smith's guilt or innocence was to be assessed wholesale, or as counsel for the defendant noted on appeal, that if Smith was not guilty of murdering Ms. Mundy, "[then] there had been a triple coincidence, which was most

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[30] *Brides in Baths. Prisoner Sentenced to Death: The Closing Scenes*, *supra* note 17 (emphasis added). Compare the card-player example with Wigmore's famous hunting example:

> [I]f A while hunting with B hears the bullet from B's gun whistling past his head, he is willing to accept B"s bad aim or B's accidental tripping as a conceivable explanation; but if shortly afterwards the same thing happens again, and if on the third occasion A receives B's bullet in his body, the immediate inference … is that B shot at A deliberately.

Wigmore, *supra* note 4, at 611.

[31] *See supra* notes 25–27 and accompanying text.

[32] *See Brides in Baths. Prisoner Sentenced to Death: The Closing Scenes*, *supra* note 17 (emphasis added).

unlikely."[33] Such confusion was not lessened by the extensive focus given to the drowning deaths of Ms. Burnham and Ms. Lofty at trial. For example, all three bathtubs were brought into the courthouse so that the jury could inspect them and consider the possibility of accidental drowning with regard to each wife individually.[34] One might well conclude, as counsel for the defendant objected on appeal, that "The appellant had been tried practically for all three murders at the same time."[35]

2.3 *Confusion in the Literature*

In the years since George Smith hanged, the commonsense appeal of the doctrine of chances has not waned – but neither has a feeling of unease about its application. Clarity over the doctrine's theory of relevance has been particularly elusive.

Part of the problem is that courts and commentators have devoted insufficient effort to understanding how the posture of a case interacts with the doctrine. For example, in attempting to explain the reasoning behind *Rex v. Smith*, proponents of the doctrine of chances have elaborated that "Either Smith was one of the unluckiest persons alive, or one or some of the deaths in question were the product of an *actus reus*."[36] This conclusion is argued to follow directly from a non-character theory of relevance: i.e. the "objective improbability" of the

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[33] *Drowned Brides Case. Smith's Appeal Dismissed: A Question of Evidence*, TIMES (London), July 30, 1915, at 3.
[34] *The Brides Case. Mr. Bodkin's Array of Coincidences: Speech for the Defence*, *supra* note 22.
[35] *Drowned Brides Case. Smith's Appeal Dismissed: A Question of Evidence*, *supra* note 33. *Contra Rex. v. Smith*, *supra* note 13 (Isaacs, L.C.J.) (observing that the jury had been instructed more than once that "they must not allow their minds to be confused and think that they were deciding whether the murders of Burnham and Lofty had been committed," and from this concluding that Smith was not effectively tried for more than the murder charged).
[36] Imwinkelried, *supra* note 11 (citing D.W. Elliott, *The Young Person's Guide to Similar Fact Evidence-I*, 1983 CRIM. L. REV. 284, 289).

phenomenal coincidence that three of Smith's wives could all drown innocently and accidentally under such similar circumstances.[37]

Focus on the implausibility of this phenomenal coincidence might well be sound if Smith had in actuality been tried for the murder of all three wives at the same time. In this case posture, the "objective improbability" of three accidental deaths would seem to support something like a *res ipsa loquitur* argument.[38] The formal inference might be described as follows: (1) it is extremely unlikely that all drowning deaths were accidental, so (2) at least one of the deaths was probably the result of murder, thus (3) a conviction should stand even if it could not be said with specificity which particular deaths were accidents and which were murders.[39]

But it is critical to recognize that the doctrine of chances relates to a different case posture. It involves a case where evidence of *extrinsic events* (i.e. the drowning deaths of Ms. Burnham and Ms. Lofty) is introduced as relevant to the determination of guilt or innocence on an *intrinsic event* (i.e. the drowning death of Ms. Mundy). The posture of a simultaneous trial is inapt because all events are intrinsic to such a trial. The task in applying the doctrine of chances to *Rex v. Smith* is not to show that at least one of the deaths was likely the product of murder (the *res ipsa loquitur* argument), but to show that evidence of the extrinsic deaths tends to increase the relative probability of guilt on

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[37] Imwinkelried, *supra* note 11; Edward J. Imwinkelried, *The Dispute over the Doctrine of Chances: Relying on the Concept of Relative Frequency to Admit Uncharged Misconduct Evidence*, 7 CRIM. JUST. 16, 18 (Fall 1992) ("Another noncharacter theory for admitting similar fact evidence is the doctrine of chances. The doctrine of chances rests on the objective improbability of coincidences.") (internal citations omitted).

[38] *See, e.g.*, RESTATEMENT (SECOND) OF TORTS § 328D (1965); RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 17 (2010); s*ee also* Daniel J. Pylman, *Res Ipsa Loquitur in the Restatement (Third) of Torts: Liability Based Upon Naked Statistics Rather Than Real Evidence*, 84 CHI.-KENT L. REV. 907 (2010); Wex S. Malone, *Res Ipsa Loquitur and Proof by Inference: A Discussion of the Louisiana Cases*, 4 LA. L. REV. 70, 70–72 (1941).

[39] *Cf.* Imwinkelried, *supra* note 4, at 587 ("The decision [posed by the doctrine of chances] is akin to the determination the trier must make in a tort case when the plaintiff relies on res ipsa loquitur.").

the intrinsic death (the *doctrine of chances* argument). A satisfactory justification labors to supply the missing link in this chain of inference.

Indeed, most of the debate in the literature on the doctrine of chances can be interpreted as competing theories of what this missing link might be. Possibly owing to the frequent discussion of a common "intent" or "design" in early treatments of the doctrine of chances,[40] critics of the doctrine have tended to assume that the missing link is a requirement that guilt or innocence be assessed all-or-nothing over the entire set of events in question.[41] As applied to the example of *Rex v. Smith*, the hypothesized inference is as follows: (1) assume that either all the deaths were accidents or all the deaths were murders, and (2) note that the probability that *every* wife drowned accidentally decreases with each additional drowned wife; (3) a decrease in the probability that every wife drowned by accident means, by assumption, an increase in the probability that every wife was murdered, so (4) it follows that the introduction of evidence of extrinsic drowning deaths increases the probability of murder for every drowning in the set, including, *a fortiori*, the intrinsic drowning for which the defendant has been charged in the present trial.[42]

When formalized into an explicit chain of inference, the all-or-nothing assumption strains credulity on several levels.[43] Rather than

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[40] *See, e.g.*, *supra* note 30 and accompanying text.

[41] This assumption is rarely explicit, but has been interpreted as the intermediate inference by critics of the doctrine. *E.g.* Andrew J. Morris, *Federal Rule of Evidence 404(B): The Fictitious Ban on Character Reasoning from Other Crime Evidence*, 17 REV. LITIG. 181, 201 (1998) ("[T]he bad act evidence supports the finding of intent only if one assumes that the character traits that can be inferred from the uncharged misconduct evidence are continuing."); *id.* ("Drawing any inferences from the fact that this defendant has an above-average history of committing *acta rea* demonstrably depends on the assumption that character is constant – that the only explanation for the repeat events is that this defendant differs from the general population in a way that explains *all* of the events.") (emphasis added).

[42] *Cf.* Wigmore, *supra* note 4, at 612 ("[T]he recurrence of a similar result (here in the shape of an unlawful act) tends (*increasingly with each instance*) to negative accident or inadvertence … and tends to establish … the presence of the normal, i.e. criminal, intent accompanying such an act….") (emphasis added).

[43] *Cf.* Imwinkelried, supra note 11, at 456 ("[I]t is a logical fallacy to leap [from the implausibility that all outcomes were accidents] to the conclusion that all the outcomes represent intentional misdeeds (intentional misconduct).").

attack its validity directly, however, critics of the doctrine of chances have focused on demonstrating how the all-or-nothing assumption undermines the validity of the doctrine itself. First, critics argue that the assumption is essentially one of "continuity of character [or propensity]," [44] rendering the ultimate doctrine-of-chances inference a special case of character or propensity reasoning.[45] Second, critics assert that aside from the all-or-nothing assumption, they can discern no basis on which extrinsic event evidence would be probative of absence of accident or mistake on the particular occasion charged.[46] The conclusion is that the doctrine of chances fails to justify the admissibility of extrinsic event evidence: either the evidence is inadmissible as being used for character or propensity reasoning, or the evidence is inadmissible as irrelevant.

Responding to these criticisms, proponents of the doctrine of chances have mainly focused on the second claim – that only the all-or-nothing assumption can establish the relevance of extrinsic event evidence under the doctrine of chances.[47] Edward Imwinkelried, for

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[44] Morris, *supra* note 41, at 203.

[45] *E.g. id.* ("In the end, the doctrine of chances cannot avoid reliance on the very character inferences that define propensity reasoning. The doctrine helps to explain the propensity intuition, but it does not provide a separate path that reaches a conclusion without using propensity inferences."); Lisa Marshall, *The Character of Discrimination Law: The Incompatibility of Rule 404 and Employment Discrimination Suits*, 114 YALE L.J. 1063, 1081–82 (2005) ("However reasonable [doctrine of chances] conclusions seem, they nevertheless rely on … propensity inferences."); Rothstein, *supra* note 10, at 1263 ("If it were not for the propensity to repeat, the chances, or the probability, that an innocent person and a guilty person would be charged repeatedly would be identical. Hence, the argument hinges on propensity and runs afoul of the first sentence of Rule 404(b).").

[46] *E.g.* Morris, *supra* note 41 ("[T]he bad act evidence supports the finding of intent *only* if one assumes that the character traits that can be inferred from the uncharged misconduct evidence are continuing. *We cannot eliminate that assumption and still treat the accumulation of evidence of repeated incidents of misconduct as probative.*") (emphasis added); Marshall, *supra* note 45 ("The data, representing the effects of prior conduct, are relevant to the present employment decision *only* insofar as they shed light on some consistency in the defendant's character.") (emphasis added).

[47] *Cf.* Imwinkelried, *supra* note 37, at 16–51 (mainly distinguishing the inference to be drawn under the doctrine of chances from the types of policy concerns thought to motivate the prohibition on character and propensity reasoning).

example, has proposed an alternative theory of the missing link relating to a variant of the previously described *res ipsa loquitur* argument.[48] As applied to the facts of *Rex v. Smith*, the reasoning appears to be as follows: (1) by admitting evidence of all three deaths, the court permits the jury to eliminate, as objectively implausible, the explanation that *all* drowning deaths were accidental, (2) by eliminating this explanation, the jury may infer an increased likelihood of *all other explanations*, (3) in some other explanations, the death of Ms. Mundy was not accidental, so (4) the existence of the extrinsic events increases the probability of murder *on the particular occasion* charged. Potential infirmities in this reasoning will become evident in subsequent analysis in this paper, but for now it suffices to note that, even assuming the argument's validity, it is difficult to square this narrow theory of relevance with the apparently critical significance of the extrinsic event evidence in *Rex v. Smith*.[49]

As this brief and greatly oversimplified exposition of the literature suggests, debate over the doctrine of chances is both confusing and confused. The problem is in large part attributable to a lack of theoretical clarity about when, why, and how evidence of extrinsic events tends to be probative of lack of accident or mistake on a particular occasion. Against this backdrop, the following section undertakes a brief exploration into the formal theory of relevance underlying the doctrine of chances. Two conclusions emerge. First, the doctrine of chances affords no novel or independent theory of relevance. The relevance of extrinsic event evidence derives indirectly from reliance upon collateral theories of relevance. Second, the use of extrinsic event evidence under the doctrine of chances needn't involve character or propensity reasoning. The doctrine thus represents a valid theory

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[48] Imwinkelried, *supra* note 11, at 452–57.

[49] *See id.* at 437-38 ("Under the doctrine, the final inference is a very limited conclusion. The final conclusion is not that all the incidents were the product of an *actus reus* or *mens rea*. Rather, the final inference is merely that one or some of the incidents were not accidents. The doctrine posits that some incidents can and, in the normal course of events, do occur accidentally. Moreover, there is nothing about the internal logic of the doctrine which singles out the charged incident as the product of an *actus reus* or *mens rea*. At most, all that the doctrine establishes is that one or some of the incidents were probably the product of an *actus reus* or *mens rea*.").

upon which extrinsic event evidence might be admitted under appropriate circumstances.

3 PROBABILISTIC FOUNDATIONS OF THE DOCTRINE

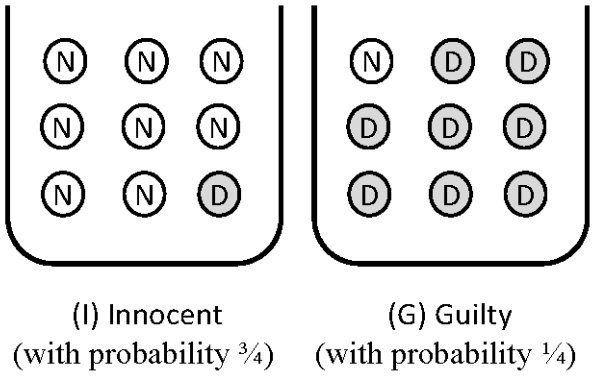
3.1 *Inference from a Phenomenal Incidence*

To see what special inferences might be drawn from a "phenomenal coincidence," it helps to start with the baseline of what can be learned from merely a "phenomenal *incidence*." In *Rex v. Smith*, for example, the prosecution was obviously free to adduce evidence (or at least draw on common experience) to the effect that a wife is unlikely to accidentally drown in her bathtub under innocent circumstances.[50] If an accidental bathtub drowning is unlikely, and if Smith could have increased the probability of drowning by engaging in some form of criminal conduct, then the observation of even a single drowned wife is itself probative of guilt.

The reasoning required to draw this inference needn't be mathematically rigorous, but a simple numerical exercise illustrates the point concisely. Consider Figure 1, a toy model that maps the bathtub drowning scenario onto the old *marbles in urns* analogy forever burned into the minds of probability students. One urn represents a husband whose conduct is innocent (I); the other represents a husband whose conduct is guilty (G). Each urn contains white marbles, representing normal baths (N), and dark marbles, representing drowning deaths (D).

[50] But *cf. Drowned Brides Case. Smith's Appeal Dismissed: A Question of Evidence*, *supra* note 33 (including an exchange between one of the justices on appeal and counsel for the defense, disagreeing over the rarity of an accidental bathtub drowning); *Trial of George Joseph Smith*, *supra* note 16, at 23 (quoting Smith for the admonition that "it is known that women often lose their lives through weak hearts and fainting in a bath").

Figure 1: A Simple Model of the Bathtub Drowning Scenario



The model incorporates a stylized form of the intuition that a wife is unlikely to drown in her bathtub if her husband is innocent, but is almost certain to drown if her husband is guilty of trying to drown her. Given that the husband's conduct was innocent, Figure 1 assigns drowning (D) an illustrative probability of one-in-nine, $P(D|I) = 1/9$; given that the husband's conduct was guilty, it assigns drowning a probability of eight-in-nine, $P(D|G) = 8/9$.[51]

The model in Figure 1 also incorporates *prior* probabilities of guilt and innocence. The qualification "prior" denotes that these are the relevant probabilities before any information is brought into consideration. Intuitively, prior probabilities are something like what the members of the jury might believe before they learn anything about the particular facts of the case before them. In Figure 1, the jury starts with the assumption that most husbands are not guilty of trying to kill their wives: the prior probability of guilt is low, $P(G) = 1/4$, and the prior probability of innocence is high, $P(I) = 3/4$.[52]

[51] The conditional probability notation $P(D|I) = 1/9$ is read "the probability of drowning given innocence is equal to one in nine." Intuitively, this is the probability of a wife drowning in the bathtub if one were to know for certain that the husband were innocent of trying to cause his wife's death.

[52] Because guilt and innocence are mutually exclusive and exhaustive, these probabilities must always sum to one. Put another way, the probability of guilt is by definition one minus the probability of innocence.

In assessing guilt or innocence, the jury compares the relative probability of each possibility.[53] Relative probabilities are typically referred to as *odds*. Before the trial begins, the prior odds of guilt are

$$\frac{P(G)}{P(I)} = \frac{1/4}{3/4} = 1/3.$$

One way to interpret the $1/3$ odds of guilt is to say that, prior to the consideration of any evidence at trial, the probability of guilt is one-third the probability of innocence.

Now suppose the jury learns that a (single) wife has been found drowned in her bathtub: the prosecution's theory is murder, the husband's explanation is accident. In this posture, can the jury infer anything about the husband's likely guilt or innocence from the fact of the bathtub drowning itself? Of course it can. The rarity of a bathtub drowning under innocent circumstances (a phenomenal event), in comparison with the likelihood of drowning in the presence of murderous intent (the natural and probable consequence such intent), makes the observation of a bathtub drowning itself probative of guilt.

A glance back at Figure 1 illustrates the reasoning. The question of the husband's guilt or innocence in this model is like being blindfolded while drawing a marble from a randomly selected urn, then removing the blindfold to try to guess which urn the marble came from. If the blindfold is removed to reveal that the marble drawn was dark, then the best guess is that it came from the guilty urn – the urn more likely to have produced a dark marble under the circumstances.

This commonsense reasoning can be formalized using Bayes' Rule,[54] a law of probability dictating how prior probabilities are updated to

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[53] *See* Chris William Sanchirico, *Models of Evidence: Survey and Assessment* 6–7 (University of Pennsylvania Law School, Institute for Law and Economics, Research Paper No. 10-28, 2010) (describing the conventional approach to understanding a fact-finder's determination of guilt in terms of the stochastic odds of guilt and innocence); *see also* Louis Kaplow, *Burden of Proof* 121 YALE L.J. 738 (2012); Edward K. Cheng, *Reconceptualizing the Burden of Proof* 122 YALE L.J. 1254 (2013).

[54] For a gentle introduction to conditional probabilities and Bayes' Rule, see LEE J. BAIN & MAX ENGELHARDT, INTRODUCTION TO PROBABILITY AND MATHEMATICAL STATISTICS 16–27 (2d. ed. 1992). For the usual application of conditional probabilities and Bayes' Rule to evidentiary functions, see Sanchirico, *supra* note 53, at 5–10.

reflect the influence of new information. The updated beliefs are usually referred to as *posterior* probabilities, to reflect that they are determined *ex post* of the integration of new information. Given that a bathtub drowning is observed, Bayes' Rule counsels that the posterior probability of guilt is equal to the ratio of (1) the probability of a drowning by murder to (2) the total probability of a drowning (i.e. the probability of a drowning by murder *plus* the probability of a drowning by accident):[55]

$$\begin{aligned} P(G|D) &= \frac{P(guilty\ drowning)}{P(guilty\ drowning) + P(accidental\ drowning)} \\ &= \frac{P(D|G) \times P(G)}{P(D|G) \times P(G) + P(D|I) \times P(I)} \\ &= \frac{(8/9) \times (1/4)}{(8/9) \times (1/4) + (1/9) \times (3/4)} \\ &= 8/11 \approx 0.73. \end{aligned}$$

This is just a mathematical formalization of the intuitive reasoning described above: having observed a drowned wife, an increased probability of guilt can be inferred from the improbability of accidental drowning in relation to the near certainty that guilty conduct would cause such a drowning. Again analogizing the observation of a drowned wife to a dark marble being drawn while blindfolded, the numerical probability that that the wife had been murdered (i.e. that the dark marble had been drawn from the guilty urn) is almost three in four, $P(G|D) \approx 0.73$, while the probability that the drowning really was just an accident (i.e. that the dark marble had been drawn from the innocent urn) is only about one in four, $P(I|D) \approx 0.27$. Before observing a drowned wife, the prior odds of guilt were one-in-three. After observing a single drowned wife, the posterior odds of guilt are much higher:

[55] The probability of a guilty drowning is defined as the probability that both (1) the husband is guilty and (2) the wife drowns. By a universal identity of probability, the probability of both guilt and drowning, $P(G \cap D)$, can be written as the conditional probability of drowning given guilt, $P(D|G)$, times the unconditional probability of guilt, $P(G)$, thus $P(G \cap D) = P(D|G) \times P(G)$. A similar derivation leads to the expression for an accidental drowning.

$$\frac{P(G|D)}{P(I|D)} \approx \frac{0.73}{0.27} \approx 2.67.$$

The updated probability of guilt is about 2.67 times the probability of innocence. Based on objective probabilities alone then, this exercise illustrates how an inference of guilt may be drawn from the observation of an event that could only otherwise be described as a phenomenal incidence.

3.2 *Inference from a Phenomenal Coincidence*

Pause for a moment to note that nothing in the preceding analysis requires or even implicates the doctrine of chances. This is reasoning based on a phenomenal *incidence*, where the only evidence considered is that of the intrinsic event – the particular drowning death for which the husband is being tried. Despite the frequency of language tying the doctrine of chances to inference from "objective probability" alone,[56] it must be remembered that no special rule of evidence is needed to permit the finder of fact to draw inferences from the relative probabilities (and improbabilities) of competing explanations. The novelty of the doctrine of chances – if any – is that it ostensibly permits the finder of fact to draw an additional inference arising from extrinsic evidence of a phenomenal *coincidence*.[57]

To continue the analysis, suppose that observation of a (single) intrinsic drowning affords an insufficiently strong inference of guilt to support a conviction. In terms of the above analysis, perhaps 2.67 odds of guilt are just not high enough to convince the fact-finder of guilt beyond a reasonable doubt. But suppose the prosecution has at its disposal evidence that another wife has drowned in a similar manner. If this extrinsic drowning were introduced as evidence, what additional inference could be drawn beyond that already afforded by the intrinsic drowning? That is, of what *relevance* would the extrinsic

[56] *See supra* note 37 and accompanying text.

[57] *Cf.* Imwinkelried, *supra* note 11, at 437 ("The proponent must establish that, together with the uncharged incident, the charged incident would represent an extraordinary *coincidence*.") (emphasis added).

event be to the determination of guilt or innocence on the intrinsic event? In undertaking to answer this question, it helps to separate analysis into each of two possible cases: (1) the case where guilt or innocence on the intrinsic event is *independent* of the extrinsic event, and (2) the case where guilt or innocence on the intrinsic event is in some way *dependent* on the extrinsic event.

3.2.1 THE CASE OF INDEPENDENT EVENTS

Two random events are said to be *stochastically independent* ("independent" for short) if their joint probability distribution is equal to the product of their marginal probability distributions.[58] The definition is opaque, but the concept is simple enough: two events are independent if the outcome of one event provides no new information about the likely outcome of the other event.[59] To illustrate, consider two consecutive flips of a fair coin – a coin with a 50 percent chance of turning up either *heads* or *tails*. If the first flip of this coin turns up heads, what is the probability of another heads on the second flip? With a little thought, it is easy to see that the probability of a heads on the second flip is still 50 percent. This is a fair coin, and the particular outcome observed by chance on the first flip does not change the equal probabilities of heads and tails on the second flip. These two flips of the fair coin are stochastically *independent* events.

Many people find the properties of stochastic independence unintuitive. Some reason that because a heads was observed on the first flip, a tails is more likely on the second flip in order that the set of outcomes better approximate the 50/50 expected average. This error in judgment is usually referred to as the "gambler's fallacy," and appears to reflect a cognitive bias in which humans perceive small samples as

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[58] For a gentle introduction to independent random events, see Bain & Engelhardt, *supra* note 54, at 27–31. For an approachable but more extended treatment, see GEORGE CASELLA & ROGER L. BERGER, STATISTICAL INFERENCE 20–26, 152–56 (2d. ed. 2002).

[59] Conditional probabilities provide a helpful interpretation of stochastic independence. If two random events, A and B are independent, then the conditional probability of either event is identically equal to the unconditional probability of that event: i.e. $P(A|B) = P(A)$ and $P(B|A) = P(B)$.

more representative of long-term averages than they really are.[60] A related cognitive failure, the "hot hand bias," leads to the opposite conclusion. Under this fallacy, the observation of a heads on the first flip is thought to make a heads more likely on the second flip. The reasoning is that seeing a heads on the first flip indicates that heads is currently a "hot" outcome, indicative of an ongoing steak of heads. Again, the underlying error apparently derives from placing undue weight on the representativeness of small samples.[61] In both cases, the observer fails to adequately comprehend the probabilistic implication of stochastic independence, leading to an inaccurate assessment of relative probabilities.

With the basic concept of stochastic independence in hand, two related propositions can be easily stated and appreciated about the type of inferences supportable under the doctrine of chances. First, if the intrinsic and extrinsic events that make up a phenomenal coincidence are stochastically independent, then the extrinsic event evidence is irrelevant to the determination of guilt or innocence on the intrinsic event. Second, if extrinsic event evidence is relevant to the determination of guilt or innocence on the intrinsic event, then it must be because the intrinsic and extrinsic events are actually stochastically *dependent* events.

The first proposition implies that admission of extrinsic event evidence under the doctrine of chances is improper when the events in question are stochastically independent. To see why this must be true,

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[60] *See* Amos Tversky & Daniel Kahneman, *Belief in the Law of Small Numbers*, 76 PSYCHOL. BULL. 105 (1971); Amos Tversky & Daniel Kahneman, *Judgment under Uncertainty: Heuristics and Biases*, 185 SCI. 1124, 130 (1974); s*ee also* Rachel Croson & James Sundali, *The Gambler's Fallacy and the Hot Hand: Empirical Data from Casinos*, 30 J. RISK & UNCERTAINTY 195 (2005) (summarizing laboratory evidence and describing the results of a field experiment). For additional discussion of the bases for this cognitive bias, see Bruce D. Burns & Bryan Corpus, *Randomness and Inductions from Streaks: "Gambler's Fallacy" Versus "Hot Hand*," 11 PSYCHONOMIC BULL. & REV. 179 (2004) and Peter Ayton & Ilan Fischer, *The Hot Hand Fallacy And The Gambler's Fallacy: Two Faces Of Subjective Randomness?*, 32 MEMORY & COGNITION 1369 (2004).

[61] *See* Thomas Gilovich, Robert Vallone & Amos Tversky, *The Hot Hand in Basketball: On the Misperception of Random Sequences*, 17 COGNITIVE PSYCHOL. 295 (1985); s*ee also supra* note 60.

consider the bathtub drowning scenario illustrated in Figure 1. Suppose a second set of urns and marbles is brought in with exactly the same probabilities as before, and suppose that when the same marble-drawing process is repeated, the blindfold is again removed to reveal another dark marble (drowned wife). If all the urns, marbles, and probabilities in the second drawing process are truly the same as in Figure 1, then the odds of guilt on the second (intrinsic) drowning can be computed exactly according to the previous analysis of a phenomenal incidence (Section 3.1); the fact that the first (extrinsic) process revealed another drowning is like a prior flip of a fair coin, revealing no new information about the intrinsic process. This means that an independent extrinsic event lacks probative value, and is by definition irrelevant and consequently inadmissible as evidence.[62]

The second proposition is the contrapositive of the first: if evidence of a phenomenal coincidence increases (or decreases) the odds of guilt on a particular occasion, then it must be because the events in question are actually stochastically *dependent* events. The definition of stochastic dependence is just the negative of independence – the probability distribution relating to one of the random events in some way depends on the outcome of the other event. Put another way, knowledge of the outcome of one event provides new information about the likely outcome of the other event.

The second proposition can be interpreted as a caution against any argument that would tend to infer guilt from the observation of a phenomenal coincidence among independent events. If, despite being applied to truly independent events, an argument nevertheless appears to establish the relevance of extrinsic event evidence, then the proffered inference must actually arise from a dependence relationship being imposed (perhaps unconsciously) by the observer. An example is the previously discussed process-of-elimination theory of relevance proposed by Imwinkelried.[63] Consider Table 1, which illustrates the joint probability distribution of guilt and innocence for the two truly

[62] *See, e.g.*, FED. R. EVID. 401, 402.
[63] Imwinkelried, *supra* note 11, at 452-57.

independent repetitions of the Figure 1 bathtub drowning scenario discussed in regard to the first proposition.[64]

Table 1: Joint Probability Distribution of Guilt/Innocence (Independent Events)

		Extrinsic Event		
		I	G	Sum
Intrinsic Event	I	0.074	0.198	0.273
	G	0.198	0.529	0.727
	Sum	0.273	0.727	1.000

The interpretation of Table 1 is straightforward. Probabilities inside the box are joint probabilities: e.g. the probability that the husband is innocent of both drowning deaths is 0.074, the probability that the husband is guilty of both drowning is 0.529. Probabilities in the "Sum" categories are marginal probabilities: e.g. the probability that the husband is innocent of the intrinsic drowning is equal to the probability of dual innocence (0.074) plus the probability of innocence on the intrinsic event and guilt on the extrinsic event (0.198), which sums to 0.273. The two events are stochastically independent by construction, so the extrinsic drowning reveals no additional information about the intrinsic drowning.

Imwinkelried's description of the process-of-elimination interpretation of the doctrine of chances is informal, but the intuition appears to be that by dismissing the possibility of truly innocent coincidence as objectively implausible,[65] the fact-finder can infer a relative increase in the probability of all other explanations, including that in which the

[64]Probabilities are calculated under the assumption of independence. For example, the probability that the defendant is innocent on both the intrinsic and extrinsic events is equal to two times the probability of innocence on a single event, $0.273 \times 0.273 \approx 0.074$; the probability that the defendant is innocent on the intrinsic event and guilty on the extrinsic event is equal to the product of the two respective probabilities, $0.273 \times 0.727 \approx 0.198$; etc.

[65] *See, e.g.*, Imwinkelried, *supra* note 11, at 443.

husband is guilty of murder on the intrinsic event.[66] Table 2 illustrates this apparent logic – the small probability of dual innocence from Table 1 is reduced to zero, and the newly freed probability mass is distributed proportionately among the remaining possibilities.[67] This leads, for example, to an increase in the probability of guilt on both events from 0.529 (Table 1) to 0.571 (Table 2).

Table 2: Joint Probability Distribution of Guilt/Innocence
(No Possibility of Phenomenal Coincidence)

		Extrinsic Event		
		I	G	Sum
Intrinsic Event	I	0.000	0.214	0.214
	G	0.214	0.571	0.786
	Sum	0.214	0.786	1.000

Again, Imwinkelried's description of the theory is largely informal, but the ultimate inference appears to be that by disregarding the possibility of a phenomenal coincidence, the fact-finder is able to infer an increase in the odds of guilt on the intrinsic event. To see the ostensible argument, compare the marginal probabilities of guilt and innocence on the intrinsic event in Table 1 and Table 2: i.e. the "Sum" column corresponding to the intrinsic event in each table. Before eliminating the possibility of a phenomenal coincidence, the odds of guilt on the intrinsic event are $0.727/0.273 \approx 2.67$ (Table 1); after

[66] *See id.* at 454 ("In the typical case, the elimination of the random chance hypothesis has the affirmative effect of increasing the probability of the remaining explanatory hypotheses, including those hypothesizing situational choice rather than choice prompted by the person's character trait.").
[67] There is no principled reason why the redistribution of probability mass should be proportional over all remaining possibilities, but lacking a more formal presentation of the process-of-elimination theory, this approach at least appears to reflect the spirit of the supporting intuition.

eliminating the possibility of a phenomenal coincidence, the odds of guilt increase to $0.786/0.214 \approx 3.67$ (Table 2).[68]

One could easily mistake this approach for a method whereby the observation of a phenomenal coincidence is itself probative of guilt on an intrinsic event – even when the events in question are stochastically independent. That is, an inference of guilt would appear to derive from nothing more than the *objective improbability* of a phenomenal coincidence alone.[69] To see why this interpretation is false, one need only pause monetarily to consider how the process-of-elimination theory establishes the relevance of extrinsic event evidence.

By eliminating the possibility of a phenomenal coincidence – the possibility, however remote, that the husband is innocent with respect to both events – the observer in the process-of-elimination theory is imposing a specific form of stochastic dependence on the joint probability distribution of the events in question. If the husband is innocent of the extrinsic event, then it is *assumed* that the husband *must* be guilty of the intrinsic event, and *vice versa*. This dependence relationship arises not from any immutable or objective property of probability itself, but rather from an assumption (similar in form to the gambler's fallacy) artificially imposed on the data by the observer.

3.2.2 THE CASE OF DEPENDENT EVENTS

The lesson learned from the case of independent events is simple but important: if evidence of an extrinsic event is even arguably relevant under a doctrine-of-chances theory, it must *always* be because some form of stochastic dependence exists between the extrinsic and intrinsic events in question. Put another way, the observation of a phenomenal coincidence is not *by itself* probative of anything. This is a killing blow for any remaining hope that the doctrine of chances

[68] In the case of Table 1, the odds of guilt are identical in every column of the table, an immediate implication of the independence of the two events. The modification resulting in Table 2 breaks stochastic independence, such that the odds of guilt are different in each column. Consideration of marginal odds simplifies exposition at the cost of precision not ultimately relevant to the present inquiry.

[69] *See supra* notes 37, 65–66 and accompanying text.

provides a *distinct*, *direct*, *novel*, *independent*, *objective*, *statistical*, or otherwise qualified theory of relevance for the introduction of extrinsic events at trial. It doesn't.

But evidence of a phenomenal coincidence can still be introduced on what could broadly be considered a *doctrine-of-chances theory*. The key is a combination of (1) the improbability of a phenomenal coincidence with (2) a theory of stochastic dependence between the intrinsic and extrinsic events in question. The dependence relationship establishes relevance of the extrinsic events to the determination of guilt or innocence on the intrinsic event. In so doing, it also determines the inferential path of the overall inference. If the argument for stochastic dependence requires character or propensity reasoning, then so does the overall doctrine-of-chances inference; but if the argument for stochastic dependence avoids any form of forbidden inference, then so does the resulting doctrine-of-chances theory.

A two-step framework for introducing evidence of a phenomenal coincidence under the doctrine of chances thus emerges. First, to establish the relevance of a phenomenal coincidence to a disputed issue of mistake or accident on an intrinsic event, the advocate must provide a theory of stochastic dependence between the intrinsic and extrinsic events in question. Second, to establish the potential admissibility of the phenomenal coincidence, the advocate must be able to show that the theory of stochastic dependence does not rely on character or propensity reasoning. Some concrete examples illustrate how this framework works in practice.

Start with the form of stochastic dependence most heavily emphasized in the literature: the all-or-nothing assumption.[70] In terms of the bathtub drowning scenario depicted in Figure 1, the all-or-nothing assumption can be thought of as a model in which two marbles are drawn with replacement *from the same urn*. In narrative terms, the two events are stochastically dependent because the husband can only either (1) be guilty of both deaths, or (2) be innocent of both deaths; a mixture of guilt and innocence is assumed impossible. Mechanically computing the probability of guilt on the intrinsic drowning is an

[70] *See supra* notes 41–42 and accompanying text.

exercise in the iterated application of Bayes' Rule, and the odds of guilt on the intrinsic event do indeed increase upon observation of the extrinsic drowning.[71] Thus, the all-or-nothing dependence relationship establishes the relevance of an extrinsic event under this broad doctrine-of-chances theory. This satisfies the first step in the framework, but a second step remains.

To satisfy potential admissibility, the all-or-nothing assumption must also avoid character or propensity reasoning. It does not clearly pass the test. The problem is that, apart from some special cases,[72] nothing logically eliminates the mixed case of guilt on one event and innocence on another.[73] Several commentators motivate the all-or-nothing assumption as a form of propensity reasoning,[74] but this fails the second step in the framework and renders the overall doctrine-of-changes inference an inadmissible form of propensity reasoning. In summary, the all-or-nothing assumption does not appear a generally viable path to admissibility under the doctrine of chances.

But contrary to claims in the literature,[75] many other dependence relationships *can* support admissibility under this understanding of the doctrine of chances. As an intuitive example, any argument for the admissibility of extrinsic events in a traditional bad-acts or uncharged-offenses context could also be used to support an analogous doctrine-of-chances argument. With the exception of "absence of mistake or

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[71] Computing the probability of guilt under the all-or-nothing assumption simply involves repeating the calculation of $P(G|D)$ illustrated in Section 3.1 but with the posterior probabilities from Section 3.1 substituted in place of the prior probabilities. Intuitively, the posterior odds of guilt and innocence assessed after observing the extrinsic drowning represent the fact-finders' *ex ante* beliefs about guilt and innocence when considering the intrinsic drowning. Working through the algebra is tedious and provides no real insights. The odds of guilt increase to about 21.33.

[72] One example where this assumption would be appropriate is assessing the nature of a common act or object. To illustrate, suppose Smith were a bathtub maker accused of selling unusually dangerous tubs. Three women drowned in Smith's tubs. On at least the question of the tubs' unusual danger, the all-or-nothing assumption would seem appropriate. If all three tubs were physically identical, then either (1) all three tubs were unusually dangerous, or (2) three tubs were safe.

[73] *See supra* note 43.

[74] *See supra* note 44–45 and accompanying text.

[75] *See supra* note 46 and accompanying text.

lack of accident" – theories that will be laid to rest in the next section, and that would be circular at any rate – all admissible uses of extrinsic acts evidence support potentially admissible theories of stochastic dependence in appropriate doctrine-of-chances contexts.

To illustrate, suppose a husband is on trial for the death of his wife who drowned in her bathtub (the intrinsic drowning) and it is known that the husband intentionally drowned a prior wife in her bathtub (the extrinsic drowning). A number of non-character and non-propensity theories may be advanced to justify introducing evidence of the extrinsic bad act in a trial on the intrinsic drowning.[76] For example, evidence of the extrinsic drowning could be argued to demonstrate the husband's intent on the intrinsic event, to demonstrate the existence of a plan of conduct involving a bathtub drowning, or similarly to demonstrate that the husband possessed the requisite knowledge to cause a bathtub drowning.[77]

Every such non-character and non-propensity argument supports a theory of stochastic dependence that could be used to construct an analogous doctrine-of-chances argument in the case where guilt on the extrinsic drowning is uncertain and the husband claims accident with respect to both deaths. An example inference based on a theory of knowledge is as follows: (1) the phenomenal incidence of even a single bathtub drowning implies a heightened probability of guilt on the extrinsic drowning, (2) if the husband were guilty on the extrinsic occasion, then his prior experience means he knew how to commit a bathtub drowning on the intrinsic occasion as well, (3) relative to the default probabilities in Figure 1, the possession of this knowledge might increase a guilty husband's probability of committing a successful drowning on the intrinsic occasion, say from $P(D|G) = 8/9$ to $P(D|G) = 1$, (4) this changes the structure of the intrinsic drowning scenario in a way that increases the odds of guilt on the intrinsic drowning,[78] thus (5) evidence of the extrinsic drowning is probative of the husband's guilt on the intrinsic occasion.

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[76] *See, e.g.*, MCCORMICK ON EVIDENCE, *supra* note 5, at §§ 186, 188, 190.

[77] *See, e.g.*, FED. R. EVID. 404(b)(2).

[78] Changing the bathtub drowning scenario in Figure 1 so that all marbles in the guilty urn are dark, i.e. $P(D|G) = 1$, increases the posterior odds of guilt from 2.67

This exemplifies how the combination of a phenomenal coincidence (two bathtub drowning deaths) with a theory of stochastic dependence (an inference of special knowledge on the intrinsic event) satisfies both steps in the doctrine-of-chances framework. First, evidence of the extrinsic death is relevant to the intrinsic event as illustrated in the above chain of inference. Second, the overall inference does not run afoul of the character/propensity prohibition because the theory of stochastic dependence is itself a recognized form of non-character and non-propensity reasoning. It must be emphasized that there is nothing remarkable about the example of knowledge as the theory of stochastic dependence in this example: a*ny* non-forbidden use of extrinsic event evidence could support a similar chain of inference in an appropriate context.

To complete the illustration, note that the strength of this form of inference grows with the improbability of the phenomenal coincidence. Suppose, for example, that two previous wives drowned in their bathtubs. As far as the dependence relationship is satisfied by an inference of guilt on *any* extrinsic event, a *res ipsa loquitur* inference can be invoked on the entire set of extrinsic events.[79] The reasoning is intuitive: if guilt on one extrinsic event is likely having observed only one such event, then guilt on *at least one extrinsic event* is even more likely when two events are observed (and would be more likely yet with three extrinsic events, etc). Combined with a theory of stochastic dependence, this stronger inference of guilt on at least one extrinsic event leads to a stronger inference of guilt on the intrinsic event.

4 IMPLICATIONS FOR LEGAL PRACTICE

4.1 *Broad Doctrinal Implications*

to 3.0. Of course, the doctrine-of-chances inference is actually weaker than this, as it operates on only the likelihood (not certainty) of guilt on the extrinsic event.

[79] To illustrate, assume the probability of guilt on a given extrinsic event is 0.73. Even assuming these events are independent, the probability of innocence on *both* extrinsic events is very small: $(1 - 0.73) \times (1 - 0.73) \approx 0.074$. Put another way, the odds of guilt on *at least one* extrinsic event is about $1 - 0.074 = 0.926$.

It may seem strange, at first, to interpret the doctrine-of-chances inference as analogous to the type of inference permitted in more typical extrinsic acts cases. The perceived novelty of the proposition reflects a combination of (1) some of the less intuitive aspects of the rules of probability and Bayesian updating, and (2) a cognitive model of evidence that has wrongly categorized how the doctrine of chances fits into the broader framework for evidence of extrinsic events. The first topic will be addressed later in this section; the second topic can be remedied immediately.

Current legal practice and commentary misses the close relationship between the doctrine of chances and more typical extrinsic bad-acts arguments. There is actually a deep and intuitive symmetry between these two inferences. As the probability of guilt or intent on the extrinsic events in a doctrine-of-chances fact-pattern becomes arbitrarily close to certainty, the doctrine-of-chances inference necessarily converges to the more familiar form of an extrinsic bad-act inference. It converges in probative value from below, so the strongest inference afforded by a phenomenal coincidence never exceeds the strongest extrinsic-act inference that could be drawn if guilt or intent on the extrinsic events were certain.

These properties are analytically apparent in the work of the previous section, but a more intuitive way to arrive at the same result is to approach the limiting argument in reverse. For example, take the facts of *Rex v. Smith*, but assume that Smith was certainly guilty of murder on both of the extrinsic drowning deaths. On what possible bases could these extrinsic deaths be introduced in a trial on the intrinsic drowning? The answer is supplied by extant law on the admissibility of various inferences to be drawn from extrinsic acts, uncharged offenses, etc. Now suppose instead that Smith's guilt on the extrinsic events was only slightly less than certain. Why should this infinitesimal decrease in the likelihood of guilt on the extrinsic events cause any significant change in the form or admissibility of inference that could be drawn from evidence of the extrinsic events? (It shouldn't.) More tellingly, how could this slight *decrease* in the probability of extrinsic guilt give birth to any new, direct, independent, or statistical inference of guilt

that wasn't already available in the more damning case of certain guilt on the extrinsic events? (It couldn't.)

The clear implication of this revised understanding of the doctrine of chances is that some reorganization of the basic legal framework on the admissibility of extrinsic events is required. Start with the inclusion of "absence of mistake" and "lack of accident" in lists of non-character and non-propensity uses of extrinsic event evidence.[80] These categories are broad, covering more than just the doctrine of chances.[81] But to the extent that the doctrine of chances is thought to contribute a novel, independent, non-character and non-propensity inference of guilt to such categories,[82] its inclusion is improper and should be discontinued. The problem is not that the doctrine of chances requires character or propensity reasoning, but that it does not afford an independent theory of relevance in the first place.

Rather, the doctrine of chances is best conceptualized as an extension of the evidentiary framework for using extrinsic bad-acts at trial. It generalizes extrinsic-acts inferences to the case where culpability or intend on the extrinsic events is uncertain, but can be inferred from the relative improbability of the set of events in question. In looking at the doctrine of chances this way, the need for an admissible theory of stochastic dependence is best seen as the intuitive analog of a need for some non-forbidden theory of relevance when seeking to introduce evidence of extrinsic bad acts in the more typical framework.

The language of a "framework" for admissibility is not hollow. As noted at the outset of this paper, much uncertainty still hangs over the boundaries of character and propensity reasoning, as well as over the normative providence of tying admissibility to such distinctions in the first place.[83] These issues – involving questions of language, cognitive

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[80] *E.g.* FED. R. EVID. 404(b)(2).

[81] *See, e.g.*, MCCORMICK ON EVIDENCE, *supra* note 5, at § 190(3).

[82] *E.g. id.* at 1039 ("*Rex v. Smith* falls in this category.").

[83] *See, e.g.*, Kuhns, *supra* note 5; Rothstein, *supra* note 10; *see also* Edward J. Imwinkelried, *Reshaping the "Grotesque" Doctrine of Character Evidence: The Reform Implications of the Most Recent Psychological Research*, 36 SW. U. L. REV. 741 (2008); Chris William Sanchirico, *Character Evidence and the Object of Trial*, 101 COLUM. L. REV. 1227 (2001). Some legal systems do away with the prohibition on propensity inference entirely. *See* Mirjan R. Damaska, *Propensity Evidence in*

psychology, and social policy – fall well beyond the scope of the present paper. But this paper *does* make the contribution of removing the doctrine of chances from the field of debate. Rather than representing an embattled inference itself, the doctrine of chances is better understood as a formula for the potential admissibility of a phenomenal coincidence when an admissible stochastic dependence argument can be articulated. The present paper is thus able to validate the doctrine-of-chances *framework* without becoming entangled in the ultimately separable question of what inferences would or should constitute admissible dependence relationships in a given context.

4.2 *Specific Evidentiary Implications*

The analysis of this paper also provides answers to some more specific questions that have long frustrated attempts to understand the operation of the doctrine of chances in practice. Admittedly, the answers provided here do not include many bright-line rules. Rather, they explain the theoretic context for each question, so that individual determinations of adequacy can be made on a case-by-case basis.

How many extrinsic events must be observed to invoke the doctrine of chances and how unlikely must it be that the extrinsic event would be observed under innocent conduct?[84] As should be clear in retrospect, the answers to these two questions are interlinked. What the doctrine of chances requires is a probabilistic inference of guilt on at least a subset of the extrinsic events in question.[85] For example, if the observation of a single extrinsic drowning is highly probative of a husband's guilt on the extrinsic occasion, then as few as one extrinsic event may suffice in

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Continental Legal Systems, 70 CHI.-KENT L. REV. 55 (1994). Indeed, the prohibition is not even uniform under the federal rules. *See* FED. R. EVID. 413–415.

[84] Rothstein, *supra* note 10, at 1263.

[85] The requisite strength of this inference of extrinsic guilt or intent is essentially a question of relevance, to be assessed on a case-by-case basis. Apart from the trivial requirement of a non-zero probability of extrinsic guilt, no bright-line rule can be articulated about a minimum probability threshold adequate to support admissibility. *Cf.* MCCORMICK ON EVIDENCE, *supra* note 5, at § 185, p. 1004 (explaining that assessment of relevance "must lie in the judge's personal experience, general knowledge, and understanding of human conduct and motivation.").

making out a doctrine-of-chances argument. If, on the other hand, a bathtub drowning is considered common enough under innocent circumstances that only a moderate inference of extrinsic guilt attaches to a given observation, then a large number of extrinsic drowning deaths may be required to raise a sufficient inference of guilt on at least one of the extrinsic occasions to support a valid doctrine-of-chances argument.

How similar must the extrinsic events be to the intrinsic event in order to invoke the doctrine of chances?[86] It may surprise to note that nothing in the doctrine-of-chances framework illustrated in Section 3.2.2 expressly depends on the extrinsic and intrinsic events being identical or even similar. Rather, this assumption enters implicitly through the requirement of a theory of stochastic dependence – dependence being difficult to articulate when the extrinsic and intrinsic events are not sufficiently related. As a practical matter, the requisite similarity of extrinsic and intrinsic events is bound to be a function of the proffered theory of stochastic dependence. A dependence link based on a showing of *modus operandi*,[87] for example, requires a much higher degree of similarity than a dependence link based on a theory of demonstrating a more general plan of conduct.[88]

Does the order of intrinsic and extrinsic events in a phenomenal coincidence affect the proponent's ability to make out a doctrine-of-chances argument? The order in which events occur generally matters in a doctrine-of-chances context. As an example, return again to the facts of *Rex v. Smith*. It is not difficult to construct a doctrine-of-chances argument under which the likelihood of Ms. Mundy's murder supports an inference of guilt with respect to the subsequent drowning deaths of Ms. Burnham or Ms. Lofty.[89] Among many possibilities, the previously discussed dependence relationship based on possession of special knowledge about the commission of a bathtub drowning suffices to link the *former* extrinsic event to the *later* intrinsic events.

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[86] Rothstein, *supra* note 10, at 1263.
[87] *See* McCormick on Evidence, *supra* note 5, at § 190(2).
[88] *See id.* at § 190(1).
[89] Recall that Ms. Mundy was Smith's first wife to have drowned in her bathtub; Ms. Burnham was the second, and Ms. Lofty the third. *See supra* notes 14–16, 21.

But this same dependence link is less persuasive in reverse. While the likely murder of at least one of Ms. Burnham and Ms. Lofty indicates that Smith possessed special knowledge at these *later* occasions, this inference does not necessarily imply possession of this special knowledge at the *earlier* date of Ms. Mundy's drowning as well.

The driving force in explaining why and how order matters is the particular dependence relationship articulated by the proponent. A stochastic dependence relationship based on knowledge appears sensitive to the temporal order of events, but dependence relationships such as a demonstration of plan of conduct or *modus operandi* may be somewhat less sensitive to temporal order.[90] At any rate, the determination whether the facts of a given case support a particular theory of stochastic dependence is not special to the doctrine-of-chances context: analogous determinations are required in assessing traditional uses of extrinsic bad-acts, uncharged offenses, etc, and translation to the doctrine-of-chances context is immediate.

What specific evidentiary hurdles must the proponent overcome to introduce evidence of a phenomenal coincidence under the doctrine of chances? As described in this paper, the doctrine of chances is not a remarkable evidentiary device, and it is accordingly not subject to any unusual evidentiary hurdles. The typical framework for admissibility does, however, present a sequence of challenges to the proponent.

First, analysis of the doctrine of chances in this paper makes abundantly clear that the extrinsic components of a phenomenal coincidence are irrelevant unless linked to the intrinsic events in question by a theory of stochastic dependence. This implicates the traditional framework of conditional relevance: the existence of a persuasive dependence relationship is a question of fact in the nature of a preliminary fact upon which the relevancy of the larger doctrine-of-chances inference conditionally rests.[91] Put another way, a doctrine-of-chances argument is not validly raised unless the proponent also articulates a motivating theory of stochastic dependence.

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[90] *See supra* notes 87–88.

[91] *See, e.g.*, FED. R. EVID. 104(a)–(b) and advisory committee note on subsection (b) (outlining the role of judge and jury in assessing the adequacy of evidence of a preliminary fact in a conditional relevancy context).

Second, whether the broader doctrine-of-chances inference escapes the prohibition on character or propensity reasoning depends on a determination whether the proffered dependence relationship requires the fact-finder to draw a forbidden form of inference. As previously noted, this type of determination constitutes an active area of debate and is the subject of a considerable body of caselaw.[92] Again, the basic inquiry is the same in the doctrine-of-chances context as it is in the more familiar extrinsic-acts case.

Third, as is true of all evidence, admissibility under the doctrine of chances can always be defeated by ad hoc balancing of probative value against risk of unfair prejudice, confusion of the issues, waste of time, etc.[93] Relevant to the inquiry are the availability of other sources of evidence,[94] the possible effectiveness of limiting instructions,[95] etc. Also relevant are pragmatic questions about the competency of fact-finders (both judge and jury) to accurately process the probabilistic arguments that underlie the doctrine of chances.

4.3 *Residual Questions about Fact-Finder Competency*

Especially at the stage of ad hoc balancing, questions are apt to arise on the competency of fact finders in drawing a permitted doctrine-of-chances inference from evidence of a phenomenal coincidence. Some such questions are inherent in any use of extrinsic bad-acts evidence. Examples include concern about fact finders deviating from a permissible inference to instead draw a forbidden character or propensity inference,[96] and fact finders deviating from focus on the intrinsic event

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[92] *See supra* notes 5, 9, 83.
[93] *E.g.* FED. R. EVID. 403.
[94] *E.g.* FED. R. EVID. 403 advisory committee note, 404 advisory committee note on subsection (b); MCCORMICK ON EVIDENCE, *supra* note 5, at § 185 p. 1009 n.66.
[95] *See, e.g.*, FED. R. EVID. 105; *cf.* United States v. Richards, 719 F.3d 746, 763–64 (7th Cir. 2013) ("Having obtained admission of [prior bad-act evidence] for a specific, non-propensity purpose, the [proponent] … must limit its use of the evidence to the purpose proffered when admitting the evidence.").
[96] *E.g.* Imwinkelried, *supra* note 11, at 457–59 (noting that a jury can *always* engage in forbidden character or propensity reasoning on its own initiative); *see also* Glen Weissenberger, *Making Sense of Extrinsic Act Evidence: Federal Rule of Evidence*

to instead judge the subject on the facts of extrinsic events.[97] The amount that trial procedures and jury instructions do to remedy these concerns is an important empirical question,[98] but not one uniquely raised by the doctrine of chances. By contrast, several other questions about fact-finder competency seem more specifically problematic in the doctrine-of-chances context.

One broad category of such concerns relates to the difficulty most people experience with the logic of probabilistic reasoning. Two examples of this difficulty were introduced earlier in the paper: the *gambler's fallacy* and *hot hand bias* illustrate instances in which intuitive reasoning leads to inaccurate conclusions about the probability distribution (actual probability of different outcomes) associated with stochastically independent events.[99] These are far from isolated examples. Overconfidence in the representativeness of small samples, and a corresponding difficulty intuiting the uncertainty inherent in small samples, appears pervasive even among sophisticated statistical minds.[100] There also appears to be widespread difficulty with Bayesian updating: at both numeric and intuitive (non-mathematical) levels, many people fail to accurately update their prior beliefs in response to the observation of new information – focusing on new information almost exclusively in some contexts, and not at all in other contexts.[101]

404(b), 70 IOWA L. REV. 579, § 3 (1985) (comparing many non-forbidden forms of bad-act inference with a corresponding potential for unfair prejudice).

[97] *See* Kuhns, *supra* note 5, at 795 ("Potential prejudice exists whenever there is a danger that the factfinder will be influenced not simply by the probative value of the evidence but also by its conclusion that a party is a bad person and, therefore, particularly deserving of punishment.").

[98] *Compare* MCCORMICK ON EVIDENCE, *supra* note 5, at § 190 p. 1058 n.111 (expressing serious doubt about the efficacy of trial instructions) *with* Imwinkelried, *supra* note 11, at 457–59 (noting that "it is an empirical question whether lay jurors are competent to comply with a limiting instruction" but ultimately concluding that cumulative procedural safeguards "afford the defendant a measure of protection against misuse of the evidence").

[99] *See supra* notes 60–61.

[100] *See generally* Tversky & Kahneman, *Belief in the Law of Small Numbers*, *supra* note 60 (describing academic insensitivity to the implications of sample size).

[101] For examples and a generally approachable introduction to this literature, see DANIEL KAHNEMAN, THINKING, FAST AND SLOW 146–184 (2011); s*ee also* Hans Ouwersloot, Peter Nijkamp & Piet Rietveld, *Errors in Probability Updating Behav-*

Another broad category of concerns arises from the closely related difficulty of subjective probability assessment – intuitive estimation of probabilities and probability distributions from mere observation of outcome evidence.[102] Well documented biases include the exaggerated perceived probability of observed outcomes (*hindsight bias*),[103] and the exaggerated perceived probability of outcomes familiar to or expected by the observer (*availability bias*).[104] More relevant to the doctrine-of-chances context, most people appear to exhibit a strong tendency to favor deterministic, causal explanations of observed events over stochastic explanations based on random chance – with the result that truly random processes are often perceived to be non-random.[105]

The uncomfortable question posed by these observations is whether juries (or judges for that matter) possess the basic competence to appropriately interpret evidence of a phenomenal coincidence in a doctrine-of-chances argument. The long history of confusion over the doctrine of chances – even among sophisticated attorneys and legal scholars – is itself evidence that the requisite probabilistic reasoning is far from obvious. Any surprise felt at the conclusions of this paper, and any intuitive "feeling" that George Smith had to be guilty (without quite being able to articulate a reason why) may similarly be consid-

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iour: Measurement and Impact Analysis, 19 J. ECON. PSYCHOL. 535 (1998); David M. Grether, *Testing Bayes Rule and the Representativeness Heuristic: Some Experimental Evidence*, 17 J. ECON. BEHAV. & ORG. 31 (1992).

[102] *Cf.* Kahneman, *supra* note 101, at 114 ("Logicians and statisticians have developed competing definitions of probability, all very precise. For laypeople, however, probability (a synonym of *likelihood* in everyday language) is a vague notion, related to uncertainty, propensity, plausibility, and surprise.").

[103] *E.g.* Baruch Fischhoff, *Hindsight ≠ Foresight: the Effect of Outcome Knowledge on Judgment under Uncertainty*, 1 J. EXPERIMENTAL PSYCHOL.: HUM. PERCEPTION & PERFORMANCE 288 (1975).

[104] *E.g.* Amos Tversky & Daniel Kahneman, *Availability: A Heuristic for Judging Frequency and Probability*, 5 COGNITIVE PSYCHOL. 207 (1973); *see also* Daniel Kahneman & Amos Tversky, *Subjective Probability: A Judgment of Representativeness*, 3 COGNITIVE PSYCHOL. 430 (1972).

[105] Kahneman, *supra* note 101, at 114 ("Our predilection for causal thinking exposes us to serious mistakes in evaluating the randomness of truly random events."); *id.* at 115 ("Random processes produce many sequences that convince people that the process is not random after all.").

ered strikes against the assumption that fact finders are apt to be very competent at applying the doctrine.

But whether these concerns truly apply with greater force in the doctrine-of-chances context than other legal contexts is hard to say. The nature of a phenomenal coincidence and the related probabilistic focus of the doctrine of chances draw attention to the role that probability plays in this context. Of course, probabilistic reasoning – in one form or another – also underlies all factual determinations and standards of proof, the very definition of relevant evidence, almost all but-for counterfactuals, and even important mixed questions of law and fact such as the negligence standard.[106] Is there any serious doubt that the same influences undermining fact-finder competence in the doctrine-of-chances context do not similarly afflict determinations made in these more familiar situations?

While it is important to recognize the question of fact-finder competence in the doctrine-of-chances context, it is (thankfully) not an issue that must be resolved here. At the stage of ad hoc balancing, the topic can and should be addressed – amidst a cloud of other equally complicated objectives and concerns – by a judge armed with the particular facts and issues of a given case. Research specifically focused on the susceptibility of judges and juries to the type of cognitive biases outlined above would be helpful in this regard, but that is a subject for another paper. The desirability of any broader *per se* rule on this topic is also a different subject for a different paper.[107]

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[106] *See supra* note 53.

[107] *Cf.* Sprint/United Management Co. v. Mendelsohn, 552 U.S. 379, 387 (2008) ("Relevance and prejudice under Rules 401 and 403 are determined in the context of the facts and arguments in a particular case, and thus are generally not amenable to broad per se rules.")

5 CONCLUSION

At the outset of this paper, it was stated that the doctrine of chances enjoys a sort of visceral, commonsense appeal. In retrospect, it must be conceded that this isn't exactly right. The intuitively appealing inference to be drawn from a phenomenal coincidence is the *res ispa loquitur* inference.[108] In *Rex v. Smith*, for example, the most compelling inference to be drawn from the "phenomenal coincidence" of three drowned wives is this: because the probability of three truly accidental bathtub drowning is so small, it seems only sensible to conclude that *at least one* of the drowning deaths *must* have been the product of intent or purposive action. The essential reasoning is that of the old idiom that *lightning doesn't strike twice* (and *definitely* doesn't strike three times).

In a trial to which all events in question are intrinsic, the *res ispa loquitur* argument carries the day. The inference is intuitive, persuasive, and imminently probative. But if it is not possible to collect all the relevant events in a single proceeding, then a different logical path must be followed for evidence of the extrinsic events to be introduced at trial.[109] It is only in this more awkward case posture that the doctrine of chances argument applies, and the associated inference is considerably less commonsensical than a casual observer might have initially supposed.

Using simple probability models and numerical examples, this paper demonstrates two important properties of the doctrine-of-chances inference applicable where some events are extrinsic to the present proceeding. First, contrary to the claims of its proponents, the doctrine of chances provides no novel or independent theory of relevance. Put another way, the inferences involved in a proper doctrine-of-chances argument require no special affordance in the law of evidence – these inferences could be validly and permissibly drawn even without the blessing of the doctrine-of-chances label.

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[108] *See supra* notes 36–39 and accompanying text.
[109] *See supra* notes 40–46 and accompanying text.

Second, contrary to the claims of its opponents, the doctrine-of-chances inference does not require character or propensity reasoning. Extrinsic event evidence may indeed be properly admissible in an appropriate context, not as a result of any metaphysical property of "objective probabilities," but because the extrinsic events are relevant on a collateral non-character and non-propensity theory of stochastic dependence that shows why the extrinsic events in a phenomenal coincidence are relevant to the intrinsic events.

An intuitive way to understand this doctrine-of-chances inference is to perceive it as a weak form of any inference that could be properly drawn if guilt, purpose, or intent on the extrinsic events were unequivocal – i.e. if the extrinsic events were extrinsic bad acts unencumbered by any probabilistic uncertainty. In retrospect, this close relationship between the doctrine of chances and more familiar case of other bad-acts is obvious. There is no logical way in which evidence of *possible* bad acts could be more probative than evidence of *definite* bad acts, so as the likelihood of guilt or intent on the extrinsic events becomes close to certain, the doctrine-of-chances inference necessarily converges from below to coincide with a more familiar definite extrinsic-acts inference.

An immediate implication of this clarified understanding of the doctrine of chances is that the theory of relevance turns on the identification of a persuasive theory of stochastic dependence between the intrinsic and extrinsic events in question. This theory of stochastic dependence in turn determines the inferential path of the broader doctrine-of-chances inference. Put another way, the role of a non-character and non-propensity argument for stochastic dependence in the doctrine-of-chances framework is analogous to the role of a non-forbidden use of extrinsic acts evidence in the more typical extrinsic bad-acts setting. At any rate, reliance on a doctrine of chances theory should no longer be treated as a discharge of the proponent's obligation to establish the relevance of a phenomenal coincidence under the facts and issues of the intrinsic case.

In closing, it is difficult to predict the overall effect of this clarified understanding of the doctrine of chances. For example, it is impossible, in the abstract, to weigh the probative value a doctrine-of-chances

argument (properly understood) against the associated potential for confusion, distraction, unfair prejudice, etc. Whether this revised understanding of the doctrine of chances leans more or less toward the admissibility of extrinsic event evidence is an empirical question, and a tough one at that. With confidence, however, it can be said that decisions of admissibility and probative value are better made when advocates, judges, and juries understand the nature of the doctrine-of-chances argument, than when the inference lies clouded in the mist of theoretic confusion.