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Hearsay Logic

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Peter Tillers and David Schum*****

I. THE HEARSAY RULE, CROSS-EXAMINATION, AND TESTIMONIAL QUALITIES

The *paterfamilias* of modern American evidence scholarship, John Henry Wigmore, argued that the hearsay rule serves the purpose of protecting the right of a party to cross-examine adverse witnesses.[1] Wigmore had a high opinion of cross-examination; he described it as the "greatest legal engine ever invented for the discovery of truth."[2] He believed that one major purpose of cross-examination is that it allows a party to explore the testimonial qualities of witnesses, such as veracity. The hearsay rule, he thought, protects the right of parties to use cross-examination to scrutinize the relevant testimonial characteristics of witnesses.[3]

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1. 5 JOHN H. WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 1362, at 3 (James H. Chadbourn rev. ed. 1974).

2. *Id.* § 1367, at 32.

3. *Id.* § 1368, at 37; *id.* § 1420, at 251 ("The theory of the hearsay rule . . . is that the many possible sources of inaccuracy and untrustworthiness which may lie underneath the bare untested assertion of a witness can best be brought to light and exposed, if they exist, by the test of cross-examination."). One should distinguish, however, between Wigmore's theory of the role of testimonial qualities for the assessment of testimonial evidence and his view of their role in witness competency determinations. Wigmore vigorously and successfully campaigned against common law rules that disqualified witnesses for testimonial defects such as "interest" or "insanity." *See, e.g.*, 2 JOHN H. WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 501, at 709 (James H. Chadbourn rev. ed. 1979) (criticizing automatic disqualification of witnesses for

Few legal scholars today have as much enthusiasm for cross-examination as Wigmore did. Moreover, many legal scholars quibble with Wigmore's view of the relationship between the hearsay rule and cross-examination. Nonetheless, Wigmore's rationale for the hearsay rule remains important. Wigmore based his explanation of the purpose of the hearsay rule on a general theory of testimonial evidence and witness credibility. Probably every knowledgeable evidence scholar today believes that any argument about the credibility of a witness that does not address the strengths and weaknesses of the witness's testimonial capacities is inadequate. Hence, today virtually every knowledgeable student of the law of evidence tacitly or expressly accepts Wigmore's general theory of testimonial credibility.[4]

In the parlance of behavioral psychology, testimonial qualities are behavioral characteristics. A surprising degree of agreement among legal scholars exists regarding the behavioral characteristics that are relevant to credibility. In discussions of the hearsay rule, it is generally said that the relevant behavioral characteristics are narration, veracity, memory, and perception.[5] Although our own taxonomy of testimonial characteristics is a bit different, we readily embrace the thesis that behavioral characteristics such as veracity are relevant to the assessment of both hearsay and in-court testimonial evi-

"madness"). However, Wigmore certainly expected and wanted the trier of fact to consider the testimonial capacities of witnesses when assessing the probative force of their testimony. *See, e.g., id.* § 477, at 635 (asserting that one method of impeachment includes showing witness's "bad character for veracity" and "poor recollection").

4. We do not mean to intimate that Wigmore invented the idea that the testimonial qualities of witnesses are important for judgments about the the credibility and probative value of testimonial evidence. However, it is safe to say that Wigmore's views of the relationship between testimonial capacity, credibility, and probative value significantly influenced American legal thinking about testimonial evidence. Wigmore's influence on the American law of evidence was enormous in his own lifetime and remains substantial today.

5. *See, e.g.*, Richard D. Friedman, *Route Analysis of Credibility and Hearsay*, 96 YALE L.J. 667, 685 (1987) (stating that the "testimonial capacities" are "perception, memory, sincerity, and articulateness"); Eleanor Swift, *A Foundation Fact Approach to Hearsay*, 75 CAL. L. REV. 1341, 1341 (1987) (listing the four testimonial qualities of perception, memory, sincerity, and language use"); Laurence H. Tribe, *Triangulating Hearsay*, 87 HARV. L. REV. 957, 959 (1974) (analyzing "ambiguity, insincerity, erroneous memory, and faulty perception"); *see also* California v. Green, 399 U.S. 149, 188 (1970) (Harlan, J., concurring) (listing "memory, opportunity to observe, meaning, and veracity"); *cf.* CHARLES T. MCCORMICK, MCCORMICK ON EVIDENCE § 245, at 726 (Edward W. Cleary ed., 3d ed. 1984) (discussing "perception, memory, and narration of the witness").

dence. Moreover, we share Wigmore's view that characteristics such as veracity are relevant for assessing testimonial evidence in general, not just for the assessment of the credibility of hearsay declarants; that is, like Wigmore, we believe that a theory of hearsay credibility must be part of a more general theory of testimonial credibility.

II. NON-LEGAL SCHOLARSHIP ON CREDIBILITY AND TESTIMONIAL QUALITIES

A. TESTIMONIAL EVIDENCE AND EMPIRICIST EPISTEMOLOGY

The law of evidence, by its nature, is a type of epistemological theory. The epistemology of the American law of evidence has an empiricist tinge.[6] The law governing testimonial evidence incorporates the key empiricist tenet that all valid knowledge of the world ultimately rests on information gained through the senses; the law of evidence permits a witness to testify only if there is some evidence showing that the witness has "personal knowledge."[7]

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6. *See* WILLIAM TWINING, THEORIES OF EVIDENCE: BENTHAM & WIGMORE 1-18 (1985) (describing the "rationalist tradition of evidence scholarship"); 1A JOHN H. WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 37 (Peter Tillers rev. ed. 1983); *cf.* BARBARA J. SHAPIRO, PROBABILITY AND CERTAINTY IN SEVENTEENTH-CENTURY ENGLAND: A STUDY OF THE RELATIONSHIPS BETWEEN NATURAL SCIENCE, RELIGION, HISTORY, LAW, AND LITERATURE 163-93 (1983). The connection to empiricist tenets is more than conceptual; it is also historical. The work of figures such as J.S. Mill and, above all, Jeremy Bentham influenced the developments in the law of evidence. Wigmore, for example, relied extensively on Bentham and, to a lesser extent, on John Stuart Mill. *See, e.g.*, 1 WIGMORE, *supra*, § 1, at 9 (quoting Bentham); 1A WIGMORE, *supra*, § 33, at 996-98 (quoting Sidgwick, a disciple of J.S. Mill). On the question of Bentham's influence on the law of evidence and legal scholarship generally, see TWINING, *supra*, at 19-108.

7. FED. R. EVID. 602 ("A witness may not testify to a matter unless evidence is introduced sufficient to support a finding that the witness has personal knowledge of the matter."). However, the legal requirement of personal knowledge is not as substantial as it might seem. Generally, it need not be shown that the witness actually have "knowledge," but only that the witness had a (reasonable) possibility of acquiring knowledge "first-hand," i.e., by personal or direct observation. MCCORMICK, *supra* note 5, § 10, at 24 ("[I]f under the circumstances proved, reasonable men could differ as to whether the witness did or did not . . . observe, then the testimony of the witness should come in, and the jury will appraise his opportunity to know in evaluating the testimony.") (footnote omitted); *see also* 2 WIGMORE, *supra* note 3, § 658, at 894 (explaining that a "witness' observation *need not be [of] positive or absolute certainty*").

The view that knowledge of the world depends on knowledge gathered through the senses is not the exclusive property of the Anglo-American law of evidence, nor is it exclusive to the legal field. This empiricist tenet informs

The law of evidence may bear the imprint of empiricist theories of knowledge, but the law's treatment of testimonial evidence is incompatible with some of the cruder variants of empiricism. The law of evidence effectively rejects the view that human beings are *nothing more than* passive receptors or collectors of sensations, "sensa," or sense experience.[8] The law assumes that witnesses may *lie*. Moreover, although hearsay theorists ordinarily do not list the objectivity or impartiality of a witness as one of the basic testimonial qualities, the law of evidence attaches considerable importance to this behavioral characteristic. It is standard legal learning that a witness may be impeached by a showing of "bias" or "interest."[9] Although legal rules allowing impeachment for bias and interest may not presuppose that people decide what to believe,[10] the law's interest in the objectivity and impartiality of witnesses at least presupposes that bias and similar matters can influence how witnesses *interpret*, or assess, their observations and perceptions. Thus, the law of evidence is not interested solely in the perceptual capacities of witnesses or in their ability to collect "raw" data.

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scholarship and research in a great many fields of knowledge. For example, the entire discipline of sensory psychophysics concerns the means by which people gain knowledge of the world from sensory evidence. *See, e.g.*, LAWRENCE E. MARKS, SENSORY PROCESSES: THE NEW PSYCHOPHYSICS (1974); S.S. STEVENS, PSYCHOPHYSICS: INTRODUCTION TO ITS PERCEPTUAL, NEURAL, AND SOCIAL PROSPECTS (1975). This body of scholarship offers some assurance, if any is needed, that the law's emphasis on the importance of direct sensory evidence is warranted.

8. It is not easy to cite examples of serious thinkers who truly believed that human beings play only the role of passive collectors of sense data. Some theorists may have taken such a view, however. For example, some strands of David Hume's work—particularly his critique of concepts of causation—suggest that he occasionally did think that human beings play a passive rather than an active role in perception and understanding. *See, e.g.*, DAVID HUME, A TREATISE OF HUMAN NATURE Book I, pt. III, §§ 1-2, 14, at 69-78, 155-72 (L.A. Selby-Bigge ed., 2d ed. 1896). There is no dearth of theorists who believe that human beings play an active role in the acquisition of sensory information and empirical knowledge. *See, e.g.*, JEAN PIAGET, THE MECHANISMS OF PERCEPTION at xv-xxix (G.N. Seagrin trans., 1969); IRVIN ROCK, THE LOGIC OF PERCEPTION 1-20 (1983).

9. *See, e.g.*, MCCORMICK, *supra* note 5, § 40, at 85-89; 3A JOHN H. WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW §§ 943-969 (James H. Chadbourn rev. ed. 1970). Indeed, the Supreme Court itself has said that this form of testimonial impeachment is permissible under the Federal Rules of Evidence. United States v. Abel, 469 U.S. 45, 51 (1984).

10. *Cf.* L. Jonathan Cohen, *Should a Jury Say What It Believes or What It Accepts?*, 13 CARDOZO L. REV. 465, 465-68 (1991) (drawing a distinction between "belief" and "acceptance").

B. Credibility and Signal Detection Theory

The view that human beings make decisions about what to say and believe and that their expectations and interests influence their beliefs is now supported by a large body of non-legal scholarship. Of particular relevance is a body of research in psychology concerning human observation skills.[11] In one of the happier instances of cross-disciplinary fertilization in psychology, some psychologists borrowed insights from a theory called signal detection theory (SDT) to study human observational and perceptual activities. SDT's original purpose was to improve the design of radar and other mechanical sensing devices, but some psychologists thought that SDT might provide a fruitful conceptual framework for experimental study of the detection, recognition, and reporting of information-carrying "signals" by human observers.[12]

SDT does not view human observers as passive collectors of signals but as active processors of sense data; it assumes that human observers make decisions about what to believe and report. The methodology of traditional research in psychology did not permit researchers to disentangle the effects of sensory and decisional variables on the reporting behavior of human observers. The methodology of SDT experiments, however, permits orthogonal or independent assessments of both a person's sensory sensitivity and her criterion for deciding whether to say "yes" or "no" in response to a question concerning the presence of some signal or stimulus. Unlike earlier studies, SDT experiments assume that a person's reported beliefs about an observa-

11. Experimental psychologists have conducted countless studies since the middle 1800s using experimental subjects to determine sensory-perceptual processes. Until recently these studies were premised on a distinction between "sensory events" and "perceptual events." Sensory events were thought to involve only sensory end-organs. These events, it was thought, were peripheral to the subject matter of psychology. Perceptual events, by contrast, were thought to be of central importance. It was believed that these events involve the brain's integration of sensory inputs with information already stored in the brain. In more recent years, a different view of sensory and perceptual processes has emerged in psychology. It is now widely believed that sensory and perceptual processes are made of the same cloth, with no sharp distinction between them. As a result, today few, if any, psychologists believe that sensory inputs are written on a blank tablet; the integrative operations of the brain are thought to influence "sensory events" and "sensory inputs" as well as "perceptual events" and perceptual processes.

12. *See, e.g.*, James P. Egan, Signal Detection Theory and ROC Analysis (1975); David M. Green & John A. Swets, Signal Detection Theory and Psychophysics (1966); Signal Detection and Recognition by Human Observers (John A. Swets ed., 1964).

tion are inconclusive evidence about what the person actually sensed. SDT assumes that on occasion a subject will believe that a signal occurred when it did not occur and that on other occasions a subject will not believe a signal occurred when it did occur.

SDT studies show that decision criteria (for saying "yes" or "no") involve matters such as expectancies and desires.[13] The insight that expectations and desires may influence the testimony of a witness is entirely familiar to students of the law of evidence. Furthermore, as we have noted already, the law of evidence assumes that human beings are more than passive receptors or collectors of sense data. The law may take comfort from the fact that scholarship in psychology and in other fields supports this assumption.

C. TESTIMONIAL EVIDENCE AND PROBABILITY THEORY

Probabilists traditionally have studied the effect of *known* events on the probability of hypotheses; few of them have studied the probative force of unknown or uncertain events on a hypothesis. In recent years, however, the phenomenon of multistage inferential reasoning has attracted an increasing amount of attention. This work has paved the way for a more sophisticated analysis of the problem of testimonial and hearsay evidence. Testimonial evidence of any kind presents the problem of "source uncertainty." Source uncertainty is a special case of the general problem of multistage, or hierarchical, inference.

An event E that serves as evidence of a hypothesis H may itself be uncertain. When this happens, it is often appropriate and necessary to treat E as a hypothesis. Moreover, if it is assumed that the probability of E, like the probability of H, may be affected by another event (e.g., X), E also may be seen as a possible conclusion based on an inference from evidence. Like any other inference, of course, this inference ordinarily is uncertain; i.e., we are not certain, given the available evidence, that we truly and really "have" E.

Figure 1 is a representation of the most simple type of multistage inference. The evidence represented by the black box in Figure 1 may be any kind of event or evidence that affects the probability of the proposition or hypothesis designated by E.

Our immediate concern is with testimonial evidence rather

13. In signal detection studies, however, it usually is assumed that an observer truthfully reports what she actually believes. In our own work, of course, we do not accept the assumption that people always are truthful.

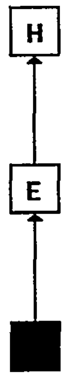

FIGURE 1

than with problems of multistage inference in general. Testimonial evidence involves a report of an event. It is both convenient and important to have a method of representation that distinguishes testimonial evidence from other types of evidence suggesting or supporting an intermediate probandum E.[14] Although both testimonial and hearsay evidence involve the problem of inconclusive chains of inference, the properties of testimonial evidence are different from those of other kinds of evidence; special forms of uncertainty emerge when the indicium of an intermediate probandum E is a report, or testimonial assertion, rather than direct physical or sensory evidence. The diagram in Figure 2 uses an asterisk to indicate that the evidence for an intermediate probandum is a person's report or assertion that something is true. Hence, in Figure 2, E* designates a report or assertion of E.

Although arguments about testimonial evidence have distinctive characteristics, they are nevertheless a form of multi-

14. Assessment of the probative value of testimonial evidence ordinarily requires at least a two-stage inferential argument. This is due to the underlying premise that all evidence is always or almost always inconclusive. If evidence in general is often or always inconclusive, any matter shown or established by a witness may in turn be uncertain or inconclusive evidence of some further hypothesis or question of fact. Hence, if we are interested in a report of an event because we believe that the event reported may serve as evidence of some other possible factual event, we have to draw at least two inferences to assess the significance of the report. However, it is possible that some testimonial evidence presents a problem requiring only a single inference. In some situations, matters such as the sensations or beliefs of a witness may be all that we wish to know.

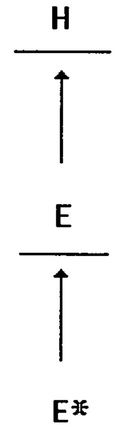

FIGURE 2

stage inferential reasoning. There are important subtleties in testimonial evidence that cannot be elicited if the chain-like character of inferential argument about testimonial evidence is ignored. In the next section we examine a theory of the relationship between judgments about the credibility of a source and judgments about the behavioral attributes of the source.[15] Described in jurisprudential terms, this theory addresses the relationship between credibility and testimonial qualities. This theory takes the view that judgments about testimonial qualities constitute links in a chain of argument about testimonial evidence. We describe this theory here because it is the foundation of an important part of our theory of "hearsay logic."

III. THE STRUCTURE OF ARGUMENT BASED ON TESTIMONIAL ATTRIBUTES

A. Credibility as a Multi-attribute Characteristic

In Part II.B. of this Article, we described a method of representing an argument in which the event that serves as evidence for a hypothesis is itself an uncertain hypothesis that rests on a report of the occurrence of that event. Although our representation of that simple type of source uncertainty is informative and useful, it is important to have a more refined

15. This theory was developed by one of the authors of this Article. *See* David A. Schum, *Knowledge, Probability, and Credibility*, 2 J. Behavioral Decision Making 39 (1989).

representation of the matters that bear on uncertainty about the link between an event E and the report of that event E*. Because uncertainty about E given E* may be affected by the attributes of the person who makes the report E*, we need a representation showing that the probative value of E* on E and H may be affected by relevant attributes of the source of the report E*. The diagram in Figure 3 is one such representation.

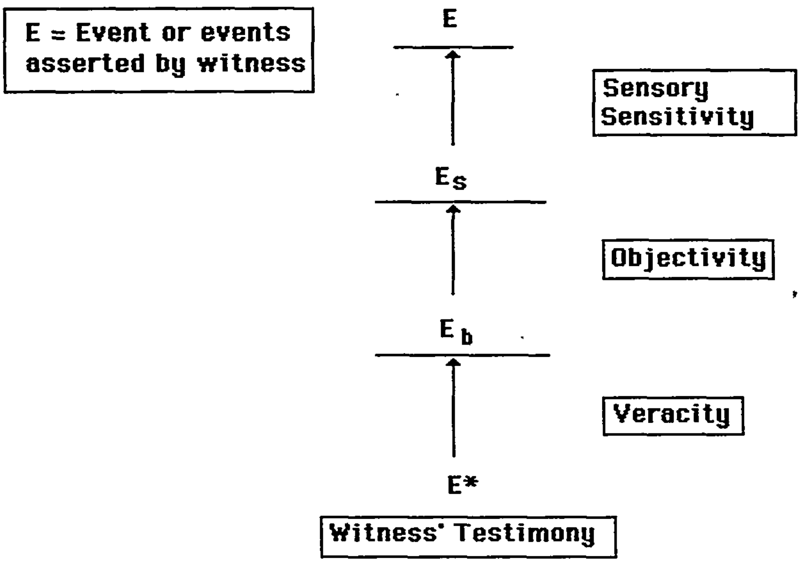

FIGURE 3

Figure 3 depicts the possibility that a witness's veracity, objectivity, and sensory sensitivity may affect the probative force of his report for the event E and the hypothesis H.[16] (For pres-

16. Many probabilists have tried to use single numbers in the conventional zero-one probability interval to grade witness credibility. *See, e.g.*, JOHN M. KEYNES, A TREATISE ON PROBABILITY 180 (1957) (addressing "truthfulness"); JOHN M. KEYNES, A TREATISE ON PROBABILITY 183 (1921) (discussing "credibility" and "reliability"); S.L. Zabell, *The Probabilistic Analysis of Testimony*, 20 J. STATISTICAL PLANNING & INFERENCE 327, 332 (1988) (discussing "credibility" and "veracity"). However, to use numbers on [0,1] single probability scales to grade credibility is asking more of single numbers than they can deliver. The basic difficulty is that a single number does not take into account the fact that assessments of credibility involve chains of reasoning or that there must be more than one probability involved in credibility assessment. Epistemologists as well as probabilists have failed to appreciate the importance of source uncertainty. Some epistemologists assert that knowledge

ent purposes, it is convenient to ignore the ultimate hypothesis or fact in issue H.) If it is assumed that the probative force of the report of E is affected by these three behavioral attributes, the diagram in Figure 3 demonstrates that the credibility of any witness is a characteristic that is affected by several distinct behavioral attributes; that is, credibility is a "multi-attribute characteristic."

The first link at the bottom of the chain in Figure 3 represents veracity assessment. The presence of this link in the chain reflects our own judgment that people do not always tell us what they believe. The arrow from E^* to E_b indicates that the witness's statement E is inconclusive evidence of her belief that E happened.

The second link from the bottom represents an objectivity assessment or judgment. This link in the chain reflects our judgment that people sometimes disbelieve or misinterpret the evidence that their senses provide. For example, we may think that if the witness expected event E to happen or wished that it had happened (or wishes that it had happened), then the witness will believe that event E happened regardless of what her senses recorded. The arrow in the second link of the chain, like the arrow in the first link, represents inconclusive evidence. In this case, the arrow indicates our opinion that a witness's belief that an event E did or did not happen is by itself inconclusive evidence of what the witness's sensory organs actually recorded.

The third link from the bottom of the chain represents "accuracy of sensory evidence." It exists because a person's sensory evidence is not always accurate. Human sensory modalities are not infallible under the best of conditions. The conditions under which observations are made may prevent otherwise well-functioning sensory organs from working effectively. Hence, even if a witness's senses give evidence of event E, this sensory evidence still is only inconclusive evidence that

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consists of "justified true belief." On this view, a person has knowledge of an event E if and only if three conditions are satisfied: (i) E did happen, (ii) the person believes E happened, and (iii) the person is justified in believing that E happened. This definition of knowledge, which is called the "standard analysis," contains important insights, but it ignores the possibility that witnesses who lack justification for believing E may nevertheless furnish evidence of E. *See* Schum, *supra* note 15, at 42; *cf.* BERTRAND RUSSELL, THE PROBLEMS OF PHILOSOPHY 131-40 (1912) (criticizing the standard analysis); Edmund L. Gettier, *Is Justified True Belief Knowledge?*, 23 ANALYSIS 121, 121-23 (1963) (same); Colin Radford, *Knowledge—By Examples*, 27 ANALYSIS 1, 1-11 (1966) (same).

E did in fact happen. Thus, Figure 3 illustrates that a person who evaluates a testimonial assertion of a witness has at least three potential sources of uncertainty[17] when deciding whether to believe an event E occured.[18]

Additional testimonial attributes easily can be incorporated into diagrams such as the one shown in Figure 3. Consider Figure 4. Unlike Figure 3, Figure 4 accommodates possible uncertainty about the intended meaning of an assertion by a witness. (Read E^c as "not-E", H^c as "not-H", etc.) Figure 4 therefore speaks to the ability of a witness to "narrate," i.e., to use language to communicate meaning. In particular, Figure 4 recognizes the possibility that a witness, by uttering certain words, may have meant to assert *either* E *or* E^c; i.e., it is possible that the report is either E* or (E^c)*. Further modifications in the ingredients of argument about credibility can be made as necessary. For example, although the argument shown in Figure 4 partitions the possible intended meanings of the witness into two disjoint and exhaustive hypotheses, the possibilities may be

17. We do not list "memory" as a separate testimonial attribute. This omission is deliberate. In our schema questions about the memory of a witness often bear on the "objectivity" of the witness. (One might also argue, however, that memory goes to the question of the accuracy of a witness's perceptual processes.)

18. Figure 3 may not depict all of the testimonial attributes that are thought to be relevant in arguments about credibility. For example, the ability of a witness to "narrate" may be relevant to the witness's credibility, but Figure 3 does not represent this behavioral characteristic. It is therefore entirely possible that Figure 3 may have to be modified to take into account additional hearsay dangers and testimonial qualities. This possibility does not surprise or disturb us. There is no "magic" in the picture of the ingredients of credibility assessment given by Figure 3 or by any similar diagram or chart. Diagrams like Figure 3 are only representations of thinking. The specific ingredients of these diagrams depend on the judgment of the people who make such representations; the judgment of the maker of an argument about credibility determines which attributes of a witness are relevant to credibility. Judgments of this sort are subjective and inevitably will differ. Because of this, some students of inference, in all likelihood, will think that the the list of credibility attributes in Figure 3 is incomplete or that it needs to be restructured.

Despite inevitable disagreements about the identity of relevant testimonial attributes, our methods of portraying the influence of testimonial attributes on judgments about credibility and probative value are useful. From a formal point of view, the significance of Figure 3 does not depend on the character or number of the testimonial attributes that it incorporates. While the choice of the attributes incorporated into Figure 3 is not unimportant from a normative or descriptive point of view, the significance of Figure 3 from a formal point of view lies in what it reveals about the structure of arguments regarding credibility that have, as their ingredients, two or more testimonial attributes.

$$\begin{array}{c}
\underline{\{H, H^c\}} \\
\uparrow \\
\underline{\{E, E^c\}} \\
\uparrow \\
\underline{\{E_s, E_s^c\}} \\
\uparrow \\
\underline{\{E_b, E_b^c\}} \\
\uparrow \\
\underline{\{E^*, [E^c]^*\}} \\
\uparrow \\
\text{TC}
\end{array}$$

TC = Testimonial Conduct

FIGURE 4

defined in a different way if that is thought to be useful or necessary.[19]

B. The Variative Nature of Argument about Testimonial and Hearsay Evidence

The assumption that the argument about credibility and the probative force of testimonial evidence is affected by judgments about several behavioral attributes of witnesses, such as veracity and sensory ability, has a number of important implications. Among the most important is the notion that one can reach the same conclusion about the credibility of a witness by a variety of argument routes. Another is that the testimony of witnesses with "defective" testimonial credentials can have substantial probative value. A third implication is that the number of inferential arguments increases exponentially as the number of testimonial attributes increases.

1. Simple Testimonial Evidence: $2^n = 8$ Paths to Probable Truth

The inference diagram in Figure 4 seems to suggest that there is one path from a testimonial report to a hypothesis. The path from a report to an hypotheses has a number of links, but it seems to be a single path. This impression is misleading. To create the conditions that will allow any kind of inference engine to run, it must be assumed that evidence may support alternative hypotheses. Each of the nodes or links in a chain of reasoning involves classes of events. In many situations, it is convenient to suppose that the classes of events are binary event classes such as $\{E,E^c\}$.[20] If this assumption is made, a three-stage credibility argument takes the form shown in Figure 5.

19. It is possible that the "testimonial conduct" of a witness was meant to assert neither E nor E^c. For example, in Kentucky v. Stincer, 482 U.S. 730, 733 (1987), the victim of alleged sodomy testified about the defendant's use of his "d-i-c-k." The Court noted that "there was some confusion as to whether [the victim] knew what a 'd-i-c-k' was, although she spelled the word at trial." *Id.* at 733 n.4. To express what the child might have been trying to assert, the hypotheses about what she meant to say may have to be partitioned differently.

20. Remember, read E^c as "not-E," or the complement of E.

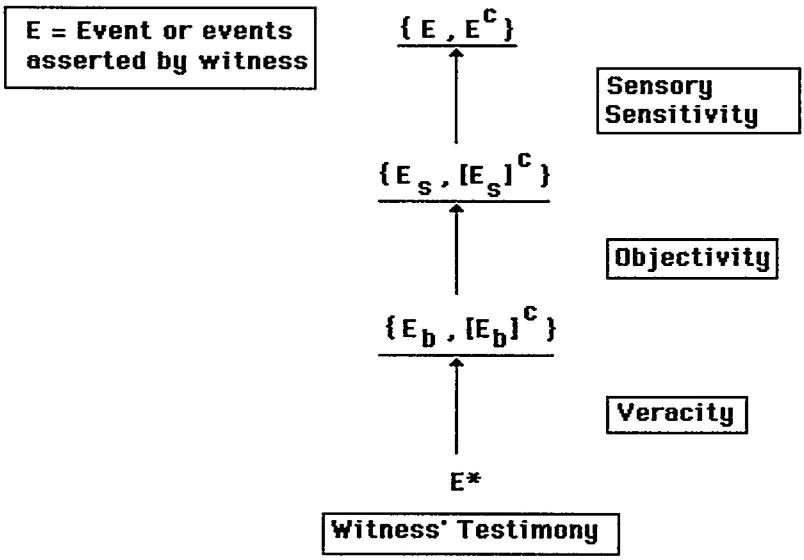

FIGURE 5

This refinement makes it apparent that there are multiple paths from a report of an event to the conclusion that the event did or did not occur. For example, E* can lead to either E_b ("witness believes that E happened") *or* $[E_b]^c$ ("witness does not believe that E happened"); E_b can lead to either E_s ("witness sensed evidence of E") or $[E_s]^c$ ("witness did not sense evidence of E"); and so on.

The argument structure shown in Figure 5 can be represented by the tree in Figure 6. This tree more palpably displays the possible reasoning routes from the report E* to hypothesis E. Inspection of the tree shows that if there are three relevant testimonial qualities, there are eight possible ways to get from "here" to "there"; for example, to go from a report E* to a hypothesis E or E^c.[21]

21. Because our present focus is on the effect of testimonial qualities on the probability that a reported event E actually occurred, we can ignore H for the time being.

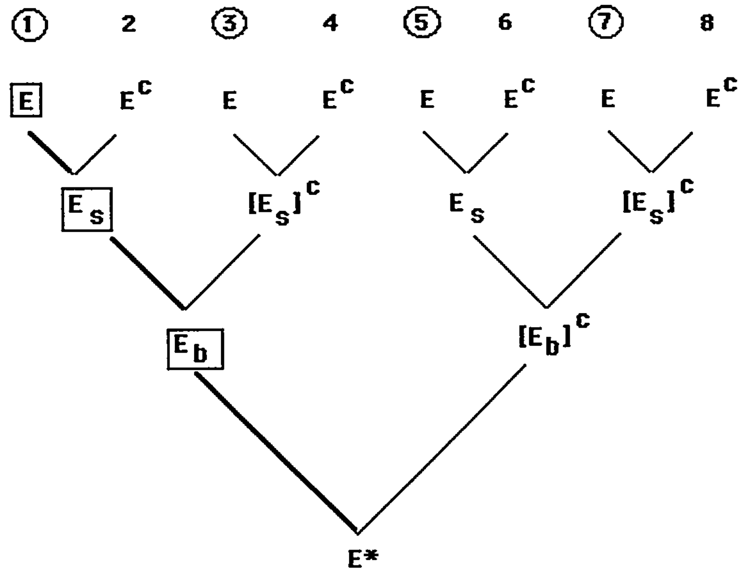

FIGURE 6

2. The Value of Liars and Other Unreliable Witnesses

The diagram in Figure 6 portrays various possible arguments or chains of inferences based on testimonial evidence. Portions of this diagram may seem counterintuitive. For example, the line of argument denoted by the circled number seven in Figure 6 indicates that the occurrence of an event E may be inferred from a witness's report even though the finder of fact believes that the witness is a liar and that the witness does not interpret the information from her senses reliably. This may seem paradoxical, but David Schum has shown that the paradox may be only apparent.[22] Under certain assumptions, liars and other unreliable witnesses can report the truth, albeit unwittingly or for reasons that they do not themselves understand or accept.[23]

At one time, the law apparently rejected the hypothesis

22. Schum, *supra* note 15, at 55.

23. *Id.* (arguing that a witness without "knowledge" may have probative evidence, and showing that under certain assumptions the testimony of a witness having totally defective testimonial attributes may have probative value).

that known liars and other unreliable witnesses can "tell" the truth.[24] Perhaps it did so by embracing the notion that a witness with defective testimonial capacities is utterly incapable of telling the truth.[25] Correlatively, some historical evidence seems to suggest that the law once supposed that witnesses fall into two and only two categories: credible witnesses and incredible witnesses. The law now recognizes, however, that the testimonial capacities of witnesses may be impaired by degrees. It also acknowledges that the testimony of witnesses with partially defective testimonial capacities can contribute to the discovery of the truth.[26]

Whether the emergence of the modern legal approach to testimonial evidence is attributable to a fundamental change in conceptions of truth and probability we cannot say. We can say, however, that modern law unquestionably treats testimonial evidence probabilistically. The notion that proof is a matter of degree and that evidence—including testimonial evidence—adds to truth by degrees, and only by degrees, now has the status of a truism.[27] However, there is an interesting and important concomitant to the truism that all proof is a matter of probability and degree. If testimonial evidence can be combined with other evidence to make a fact more probable than in the presence of only a single item of testimonial evidence, it follows that truth is in the eye of the beholder of evidence—in

24. *See* WILLIAM E. NELSON, THE AMERICANIZATION OF THE COMMON LAW: THE IMPACT OF LEGAL CHANGE ON MASSACHUSETTS SOCIETY, 1760-1830, at 24-25 (1975) (noting that courts would bar potentially deceiving evidence from going to the jury).

25. *Id.* at 25-26 ("The [North American] colonial approach to evidentiary questions rested in large part . . . on a conception of truth that we do not share. The conception—that truth would emerge not from a weighing of credibilities and probabilities, but from the sanctity of an oath—looked backward to earlier times, in which God-fearing men had attached enormous importance to a solemn oath."); *cf.* SHAPIRO, *supra* note 6, at 163-93 (arguing that there has been a fundamental change in conceptions of truth and probability during the last several centuries and tracing the emergence of the modern, probabilistic conception of truth to several sectors of culture, including law). However, it is not unreasonable to wonder if the difference between modern and medieval conceptions of factual inference and proof has been exaggerated and overdrawn. *See, e.g.*, Mirjan Damaška, *Of Hearsay and Its Analogues*, 76 MINN. L. REV. 425, 435-36 (1992) (describing a decidedly "modern" view of the dangers of hearsay by the medieval Roman-canon law).

26. 2 WIGMORE, *supra* note 3, § 475, at 633-34 (arguing that witness competency rules generally are or should be determined by the relevance standard).

27. 1A WIGMORE, *supra* note 6, § 37.4, at 1030; *see also* FED. R. EVID. 401 (" 'Relevant evidence' means evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence.").

this case, the trier of fact—and not in the evidence that the trier beholds.[28] This holds true even if the evidence that the trier beholds is the testimony of a witness or the witness herself. The trier of fact is entitled to make more, or less, out of the testimony of a witness than the witness does herself, and the trier may give that testimony a vector that is the opposite of that indicated by the witness. In short, the significance of testimonial evidence lies in the eye of the beholder of the evidence. This principle implies that the testimony of a witness with poor testimonial credentials can have substantial probative value. It also implies the far more surprising proposition that the beholder of testimonial evidence can draw an inference that is the direct opposite of the witness's assertion.

The beholder of testimonial evidence must—or so we think—attach significance to testimonial attributes when assessing the credibility of witnesses. It does not follow, however, that the trier cannot infer anything of importance from the testimony of a person she thinks is a liar or has some other defect. If the significance of evidence is in the eye of the beholder, it is equally true that the testimonial attributes of witnesses are themselves evidence for the trier of fact. The trier is entitled, epistemologically and inferentially speaking, to use evidence about those attributes to draw conclusions that the witness herself may not draw or may not want the trier to draw. Hence, it is not surprising in principle that a trier of fact may rationally use a testimonial assertion E* to conclude not-E. The real issue is *when* a trier of fact may do so, not *whether* she may do so.

The proposition that liars and unreliable witnesses may report the truth has a flip side. The flip side is that honest and reliable witnesses may report untruths. In older American cases, it often was said that the testimony of a credible witness must be taken as true.[29] Similar statements still are made today.[30] As a matter of epistemology and inferential theory, how-

28. If, that is, testimonial evidence, like all other evidence, is a brick that can be used with other bricks to build a wall. *See* MCCORMICK, *supra* note 5, § 185, at 543 (noting that "a brick is not a wall").

29. See pertinent cases gathered in Olin Guy Wellborn III, *Demeanor*, 76 CORNELL L. REV. 1075, 1101 n.127 (1991) (collecting cases).

30. Most courts today say that the uncontradicted and unimpeached testimony of a disinterested witness must be believed. *Id.* at 1100. The meaning of this principle is unclear. Under one interpretation, it is practically a tautology: the report of a perfect witness must be believed if no evidence apart from the witness's testimony suggests anything other than the facts to which the witness attests. However, if the principle—whatever it may mean—is something more than a tautology, the law does not, or should not, embrace it. No witness

ever, the idea that the testimony of credible witnesses must have probative value cannot readily survive. The reason is that the trier of fact, not the witness, is the trier of fact. The value of the testimony of an unimpeached witness, as well as the value of the testimony of a witness with absolutely rotten testimonial credentials, depends on what is in the trier's mind.[31]

The proposition that the testimony of a liar can point the way to the truth is not counterintuitive. Consider the testimony of Worst Witness. Worst is a pathological liar. He also has a "reading disorder" which sometimes causes him to make a faulty substitution of letters. However, he does not know he has a reading disorder. The mendacity of Worst Witness takes a very specific form. Worst says X whenever he believes not-X, and he says not-X whenever he believes X. Because of this learning disorder, Worst reads the letter "i" whenever the letter actually is "y," and he reads "y" whenever the letter is actually "i." Worst becomes a witness in a criminal trial. David Defendant is charged with throwing lye on his ex-wife's face on June 1, 1990. Independent evidence shows that on May 27, 1990, Worst said to Defendant, "Isn't that lye you just bought?"; in response, Defendant scribbled a note to Worst. The prosecutor authenticates this note and introduces it into evidence.

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actually is perfectly credible; any real-world witness may have testimonial defects, such as observational mistakes and memory lapses. Moreover, if the trier of fact, not the witness, is entrusted with deciding facts, the trier is entitled to find some significance in the testimony of a highly credible witness that the witness herself does not see. If the law says that a trier must believe an unimpeached, uncontradicted, and seemingly disinterested witness, it does so for some reason or reasons other than the supposition that such a witness is perfectly credible.

31. Two versions of the theory that the testimony of liars may have probative value have been articulated. The less radical version asserts that the testimony of a liar that event E occurred may offer significant support for the inference that E did occur. The more radical version asserts that a liar's statement that E did not occur may offer significant support for the inference that E did occur. One commentator has noted that "[h]undreds of cases" hold that a jury may not infer event E on the basis of "disbelief" of the testimony of a witness who asserts not-E. Wellborn, *supra* note 29, at 1101. Our analysis, however, suggests that there is no fundamental distinction between the less radical and the more radical version of the thesis that the testimony of liars may have probative value. While a parsing of the "hundreds of cases" referred to by Professor Wellborn is beyond the scope of this paper, we suspect that careful inspection of those cases would show that, in specific circumstances, the law will allow a trier of fact to infer E from testimony that is not-E. If so, the "hundreds of cases" seemingly saying the opposite may turn on distinctions such as the one we later make between a testimonial assertion that rests on personal knowledge and a testimonial assertion not based on personal observation. *See infra* part IV.D.

However, part of the note—the right-hand portion—has been ripped off. The words on the remaining portion of the note say, "That's no." The prosecutor takes a shot in the dark and asks Worst whether the next word in the note was originally "L-I-E" or "L-Y-E." Worst answers, "L-I-E." Is the testimony of this learning disabled liar probative? Now change the problem. First, suppose that Worst does not have a learning disorder. Second, suppose that in response to the prosecutor's question, Worst states, "L-Y-E." Does the testimony of this non-learning disabled liar have any probative value?

In both cases, Worst is a liar, but in both cases, Worst's testimony has affirmative probative value on the issue of Defendant's guilt. Although the reasons why the two answers have probative value are different in each case, the answers by Worst have probative force because of the evidence the trier has, and the conclusions he reaches, about Worst's testimonial qualities. In the first case, Worst's answer has probative value because the trier believes that the result of the combination of pathological lying and learning disorder makes Worst unwittingly say the truth. In the second case, Worst's answer has probative value because the trier believes that Worst, being a special kind of pathological liar, says "y" when he actually believes "i"; believing what he believes about Worst's proclivity to lie, the trier infers that Worst believes "L-I-E" precisely because Worst asserted "L-Y-E." In this second case, the trier infers the opposite of what Worst asserts. However, in either version of the problem, the trier acts rationally—given what he infers in each case about Worst's testimonial attributes and the way he believes, or infers, that they interact.

The Worst Witness hypotheticals illustrate an important consequence of the assumption that credibility is a multi-attribute characteristic. If judgments about the credibility of a witness are not irreducible, but depend on further or separate judgments about at least several attributes or a witness, the relationship between credibility and testimonial capacities is not necessarily or ordinarily direct.[32] The Worst Witness hypotheticals merely illustrate this basic point.[33]

32. *See infra* part IV.A.

33. If it is granted that the relationship between credibility and testimonial attributes is not direct and that the probative force of testimonial evidence depends on a wide variety of circumstances, assumptions, and judgments, then a legal rule that allows the use of hearsay evidence only when the testimonial capacities of the hearsay declarant are shown to be strong results in something of an inferential puzzle. Statements by a declarant with weak credibility cre-

3. Simple Hearsay Evidence: $2^6 = 64$ Paths to Probable Truth

We already have shown that, under certain assumptions, there are eight possible argument routes to the probable truth of a factual hypothesis and its complement.[34] Inspection of Figure 6 also shows that the number of possible arguments based on testimonial evidence grows exponentially as the number of links in the chain of reasoning increases. In fact, the number of possible arguments is 2^n, where n represents the number of links in the chain of reasoning.

Hearsay evidence involves an assessment of two human sources of evidence instead of one. The length of the chain of reasoning doubles when a trier assesses the probative force of hearsay evidence. The trier must assess not only the testimonial qualities of the in-court witness but also the testimonial qualities of the out-of-court declarant. If it is assumed that the assessment of testimonial evidence involves three inferential stages, the assessment of hearsay evidence consequently requires six links in the chain of inferences. This means that the number of possible arguments about the probative force of hearsay is 2^6, or 64.[35] In fact, we shall show that the number of possible arguments based on hearsay evidence often greatly exceeds 64. The complexity of argument about hearsay raises the question of the practical and cognitive manageability of argument about hearsay evidence. We shall discuss this question in the last part of this paper after we have more fully illustrated the complexity and intricacy of "hearsay logic."

IV. A BAYESIAN PERSPECTIVE ON HEARSAY EVIDENCE

We have shown that chains of argument involving out-of-court utterances can assume a variety of shapes. Now we wish to see if probability theory can clarify some of the features of

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dentials may have substantial probative value; statements by a declarant with strong credibility credentials may have little probative value; and assertions by witnesses possibly may even support the opposite of what they assert. If this is true, is it possible to explain or defend the hearsay rule on the basis of inferential considerations? This question deserves more space than we can devote to it here.

34. This holds if judgments about credibility are assumed to involve inferences about three separate testimonial qualities that work in combination to affect the credibility of a witness.

35. If we assume, as the law does, that the number of relevant testimonial qualities is four rather than three, the number of possible arguments about hearsay is 2^8, or 256.

those various patterns of argument. We begin not with the most complex forms of argument concerning hearsay but with the most simple. We first examine an inferential argument that takes the form of a single chain. In this kind of argument, each link in the argument is connected to only one other link. In visual terms, the pattern of argument takes the form of a single vertical chain of inferences.

A. Likelihood Expressions in Hierarchical Inference

From a Bayesian perspective, the probative force of an event is a function of two conditional probabilities, $P(E|H)$ and $P(E|H^c)$. The term $P(E|H)$ represents "the probability of E given H"; and $P(E|H^c)$, "the probability of E given not-H." Consider an illustration. Suppose E represents "David Defendant's escape from jail" and H represents "David Defendant killed Sam Smith." Suppose that we somehow know that David Defendant escaped from jail. The term $P(E|H)$ asks for a judgment about the probability of David Defendant's escape from jail if David Defendant killed Sam Smith. The term $P(E|H^c)$ asks for a judgment about the probability of Defendant's escape from jail given the assumption that David Defendant did not kill Sam Smith. Bayesian theory instructs us that the more the two terms $P(E|H)$ and $P(E|H^c)$ differ, the stronger the probative force of the known occurrence of event E is. Conversely, if the probability of the evidence's existence is the same whether the hypothesis is true or false, the event E is "worthless" evidence.[36]

Many standard accounts[37] of Bayesian analysis of evidence assert that the probative impact of an event (e.g., "David Defendant's escape from jail") on another hypothesis (e.g., "David Defendant killed Sam Smith") is given by the likelihood ratio:

$$L_E = \frac{P(E|H)}{P(E|H^c)} \qquad (1)$$

36. Formally expressed, this means that if $P(E|H) = P(E|H^c)$, any report about event E, hearsay or otherwise, has no probative value. In the simple hearsay case described below in part IV.B., this means that L for $E^*_{2,1} = 1.0$. For example, suppose that we have a hearsay report of a suspect's escape from jail. If we believe that the probability of the suspect's escape from jail was the same whether he was guilty or whether he was innocent, the report of the suspect's escape cannot have any probative value on the question of guilt. One might say in this instance that event E is not relevant in any way to the probanda $\{H,H^c\}$.

37. *See, e.g.*, Richard O. Lempert & Stephen A. Saltzburg, A Modern Approach to Evidence 159 (2d ed. 1982); Richard O. Lempert, *Modeling Relevance*, 75 Mich. L. Rev. 1021, 1042 (1975).

One of the advantages of this likelihood expression is its simplicity. Another is that it does not require a determination of the individual values of $P(E|H)$ and $P(E|H^c)$; the ratio $P(E|H)/P(E|H^c)$ requires only a *comparative* judgment of the probability of E under the alternative assumptions of H and H^c. For example, if it is known that David Defendant escaped from jail, the likelihood ratio for "David Defendant's escape from jail" can be extracted without determining the magnitude of the probability of Defendant's escape from jail if Defendant did kill Sam Smith or the magnitude of the probability of his escape if he did not kill Sam Smith. This comparative judgment merely requires a judgment of the comparative size of these probabilities. Thus, if a judgment is made that Defendant's escape from jail was three times more probable if Defendant killed Sam Smith than if he did not, this is sufficient. It is not necessary to determine whether the probabilities of an escape from jail under the alternative assumptions of guilt and innocence were .3 and .1, .9 and .3., or any other pair of specific probabilities that maintains the ratio 3:1.

There is nothing "wrong" with the likelihood ratio $P(E|H)/P(E|H^c)$, but it cannot be used to represent the probative force of circumstantial evidence, testimonial evidence, or hearsay evidence. The ratio $P(E|H)/P(E|H^c)$ expresses the probative force of an event E on hypotheses $\{H,H^c\}$ only if event E is known. It does not do so if the event E is uncertain. Of course, the event E may, in fact, be uncertain. (For example, although we have assumed that it is known that David Defendant escaped from jail, it may be uncertain whether he did so.) An event E is uncertain whenever it is merely a possible inference.[38] If an event E is itself nothing more than a possible inference based on evidence, the probative force of E on $\{H,H^c\}$ rests on a chain of inferences; i.e., the inferential reasoning leading to E is "catenated," "cascaded," or "hierarchical." Schum has shown that the probative force of an uncertain

38. More precisely stated, E may be a hypothesis rather than a known event or fact. If the truth of E cannot be shown deductively, a judgment about E must involve an inference. However, all inferences about factual hypotheses are uncertain. We say this even though it is true that standard probability theory allows the possibility of an utterly certain inference; formally speaking, utterly certain inferences and utterly impossible inferences are merely special cases of conditional probability. However, we refuse to call an utterly certain inference a true inference about a factual hypothesis. A conclusion can be certain only if it is logically entailed by its premises. Factual inference involves a type of inductive reasoning rather than deductive reasoning. An inductive inference is never certain.

event E in a chain of inferences is affected by the rareness, or absolute improbability, of that event.[39]

In the simple case we have posited, the probative force of evidence E* about event E in an hierarchical inference structure is:

$$L_E^* = \frac{P(E|H_1)[h_1 - f_1] + f_1}{P(E|H_2)[h_2 - f_2] + f_2} \qquad (2)$$

In this equation, H_1 and H_2 are any two disjoint hypotheses.

Assuming conditional independence of E*, and $\{H_1, H_2\}$ conditional upon E or E^c, Equation 1 may be written thus:

$$L_E^* = \frac{P(E|H_1)[h - f] + f}{P(E|H_2)[h - f] + f} \qquad (2a)$$

Equations 2 and 2a make use of the terms "h" and "f." These terms are borrowed from signal detection theory. The symbols h and f are conditional probabilities. The term h corresponds to $P(E^*|E)$, and the term f corresponds to $P(E^*|E^c)$. The symbol h thus represents a "hit," or "the probability of a hit"; i.e., the probability of testimony E* when E is true. The symbol f represents "the probability of a false positive"; i.e., the probability of testimony E* when E is not true. Roughly speaking, then, a signal has probative value if h and f differ. When h = f, then testimony E* has no probative value.

Equations 2 and 2a show that in the context of hierarchical inference—which is to say, in almost every real-world inferential context—the probative value of an event does not depend solely on the ratios between hits and false positives. Another way to express equation 2a is:

$$L_E^* = \frac{P(E|H)\,[h - f] + f}{P(E|H^c)\,[h - f] + f} = \frac{P(E|H) + [h/f - 1]^{-1}}{P(E|H^c) + [h/f - 1]^{-1}} \qquad (2b)$$

Equation 2b shows that, in multistage inferential argument, the value of L_E^*—i.e., the probative value of testimony E*—is determined by the difference between $P(E|H)$ and $P(E|H^c)$ and not simply their ratio.[40] For example, consider the following two pairs of conditional probability judgments:

(a) $P(E|H) = 0.9$; $P(E|H^c) = 0.09$
(b) $P(E|H) = 0.09$; $P(E|H^c) = 0.009$

39. Alternatively stated, in hierarchical inference, we need the individual likelihoods $P(E|H)$ and $P(E|H^c)$ and not just their ratios. *See, e.g.*, Ward Edwards et al., *Murder and (of?) the Likelihood Principle: A Trialogue*, 3 J. BEHAVIORAL DECISION MAKING 75, 77 (1990).

40. *Id.*

Under Equation 1 in both of these cases, $L_E = P(E|H)/P(E|H^c) = 10$; i.e., the likelihood ratio is the same. But Equation 2b, which gives the likelihood ratio for the probative force of testimony E^* about event E, shows that the probative value of E^* is not the same in the two cases if E is an inferred or reported (and therefore uncertain) event. The reason is that, in case (b), event E is improbable whether we assume H or assume H^c; i.e., it is a rare event. Although cases (a) and (b) produce the same ratio—10/1—the difference between $P(E|H)$ and $P(E|H^c)$ is not the same in the two cases. In case (a), the difference is 0.81, and in case (b), it is 0.081.

In non-hierarchical inference, the relevant likelihood judgment depends only on an assessment of the ratio between $P(E|H)$ and $P(E|H^c)$. Hence, it is not necessary to determine the individual values of $P(E|H)$ and $P(E|H^c)$; it is only necessary to determine the ratio between these two conditional probabilities. However, in hierarchical inference, it is necessary to establish the differences between $P(E|H)$ and $P(E|H^c)$ and not merely their ratios. Thus, it is necessary to have the individual values of $P(E|H)$ and $P(E|H^c)$; that is, it is necessary to make judgments about the rareness, or improbability, of E given H and, alternatively, given H^c. The simple ratio $L_E = P(E|H)/P(E|H^c)$ suppresses the rareness of E under those two conditions and therefore does not display the differences between the rareness of E under H and the rareness of E under H^c. Note that in the *special case* that determines equations 2a and 2b, we need only the *ratio* h/f.

B. HEARSAY LOGIC AS A THREE-STAGE ARGUMENT

1. The Probative Value and Credibility of Hearsay Evidence

Figure 7 represents the simplest imaginable hearsay problem for three reasons. First, there is a single out-of-court declarant, or primary witness, W_1, and there is a single in-court declarant, or secondary witness, W_2.[41] Second, the reasoning stages shown in Figure 7 are in their undecomposed form; that is, the pattern of inference shown ignores matters such as veracity, objectivity, sensory sensitivity, and ability to use language. Finally, there are no direct links between event classes and "ultimate facts in issue"; that is, intermediate hypotheses

41. This assumes that a courtroom witness's report of his own statement is not "true" hearsay. In this Article, we do not discuss the issue of prior statements by testifying witnesses.

are relevant to the hypothesis $\{H,H^c\}$ only by the argument shown in Figure 7, and by no other chain of inferences.

$\{H, H^C\}$ H is some probandum.

$\uparrow$

$\{E, E^C\}$ E is some event that is probative of H or H^C.

$\uparrow$

$\{E^*_1, E^{*C}_1\}$ E^*_1 is the assertion by out-of-court declarant or Primary Witness W_1 that event E happened.

Read E^{*C}_1 as "W_1 did not assert that E happened."

This covers two possibilities: (1) W_1 asserted that E did not happen, and (2) W_1 made no assertion at all.

$\uparrow$

$E^*_{2,1}$ W_2 is the in-court declarant or Secondary Witness.

Read $E^*_{2,1}$ as "W_2 asserts that W_1 asserted that event E occurred."

FIGURE 7

According to Bayes' Rule, the probative value of $E^*_{2,1}$ on $\{H,H^c\}$ is given by the likelihood ratio in Equation 3 in the box in Figure 8; i.e., the value of $L_{E^*_{2,1}}$ is the probative value of a report by a courtroom witness of a statement allegedly made by another person.

EQUATION 3

$$L_{E^*_{2,1}} = \frac{P(E|H) + C}{P(E|H^c) + C}, \text{ where } C = \left[\frac{h_1}{f_1} - 1\right]^{-1} + \frac{\left[\frac{h_2}{f_2} - 1\right]^{-1}}{(h_1 - f_1)}$$

Read: $h_1 = P(E^*_1|E)$ as "the probability that Primary Witness W_1 told Secondary Witness W_2 that E occurred, if E actually occurred"

$f_1 = P(E^*_1|E^c)$ as "the probability that Primary Witness W_1 told Secondary Witness W_2 that E occurred, if E actually did not occur"

$h_2 = P(E^*_{2,1} | E^*_1)$ as "the probability that W_1 tells us that W_2 said that E occurred, if W_2 actually did so"

$f_2 = P(E^*_{2,1} | E^{*c}_1)$ as "the probability that W_2 tells us that that W_1 said that E occurred if (i) W_1 said that E did not occur, or (ii) W_1 said nothing at all [i.e., W_2 made up this assertion]"

FIGURE 8

The probative force of the testimony of a witness differs from the credibility of a witness. For example, if a witness with golden testimonial credentials testifies about an event that is strongly probative of H, his testimony has greater probative value than if he testifies to an event that only weakly supports H. The probative force of the evidence shown in Figure 8 is given by $L_{E^*_{2,1}}$. The credibility of W_1 and W_2 taken separately is given by the ratios h_1/f_1 and h_2/f_2, respectively. The term C in Equation 3 captures the aggregate credibility of *both* witnesses in our problem, the courtroom witness W_2 and the hearsay declarant W_1.[42]

42. C's representation of their aggregate credibility thus illustrates that the value of hearsay rests upon the credibility of two interacting witnesses.

Small values of C are associated with large aggregate testimonial credibility. The value of C depends on probabilities, but is not itself a probability. C is defined outside of the [0,1] interval. As the aggregate credibility of two witnesses in a hearsay chain increases, the probative value of hearsay evidence also can increase. However, consider the following ratio in Equation 3:

$$\frac{P(E|H) + C}{P(E|H^c) + C} \tag{3}$$

Inspection of this ratio shows that C acts as a "drag" on the change of opinion because the greater the value of C, the more the likelihood ratio approaches one (1). As it does so, the probative value of the hearsay evidence for the hypothesis H (or for the hypothesis H^c) decreases. Thus, if C is very large, the probative value of the hearsay evidence is very small. If the aggregate credibility of the two witnesses is very *substantial*, C is very *small*, and the probative value of the hearsay evidence therefore may be substantial.[43]

Large values of C are inversely related to aggregate credibility of the two witnesses in our undecomposed hearsay problem because the value of C in Equation 3 is a function of the two inverses[44] involving the terms h and f.[45] Recall that h represents the "hits," and f, the "false positives." If the two witnesses in the hearsay problem are considered separately, their credibility increases as their ratio of "hits" to "false positives" increases; i.e., as the ratios h_1/f_1 and h_2/f_2 increase. When the credibility of these two witnesses (taken separately) becomes very substantial—i.e., as the hit ratios h_1/f_1 and h_2/f_2 become very large—the value of the terms involving the inverses of

43. When the aggregate credibility of the two witnesses is enormous, the hearsay evidence may have substantial probative value for H. Strong aggregate credibility does not guarantee that hearsay evidence has substantial probative value. If E offers only weak support for H, all the aggregate credibility in the world in support of E will not make the hearsay evidence provide strong support for H.

44. The inverses are the terms that have [−1] attached to them. These terms may also be expressed in the following way:

$$[(h/f) - 1]^{-1} = 1/[(h/f) - 1]$$

The term on the left is nothing more than a convenient way of writing the term on the right. Read the inverse operation as "the number one divided by whatever term the inverse is applied to." (The inverse operation corresponds to the properties of negative powers. For example, $X^{-1} = 1/X$.)

45. The terms h and f both are conditional probabilities, and their limits are therefore zero and one. By convention, no probability value can exceed 1 nor fall below 0.

these ratios becomes very small; the value of C also becomes small; and, if event E has strong probative force on $\{H,H^c\}$, the hearsay evidence of E also has strong probative force.

A more formal way to consider the effect of large values of C on the probative value of hearsay evidence is to consider what happens to the terms with inverses as $h \rightarrow 1.0$ and $f \rightarrow 0.43$ (read the arrow $\rightarrow$ as "approaches"). As h and f approach these limits, the ratio $h/f \rightarrow \infty$; i.e., the value of the ratio approaches infinity. This means that the value of the whole term approaches zero. The probative value of the hearsay evidence therefore approaches the simple ratio $P(E|H)/P(E|H^c)$.

The term C not only captures how much drag credibility exerts on change of opinion about the "fact in issue" but also has directional properties. C captures whether aggregate credibility judgments move opinion toward H or toward H^c. When C is positive, the hearsay evidence will favor inferentially whatever probandum E favors. For example, if E favors H over H^c, a positive value of C will make the hearsay evidence favor H over H^c. If C is negative, however, the hearsay evidence will favor whatever hypothesis E^c favors. It is a characteristic of Bayesian inference that if E favors H over H^c, E^c must favor H^c over H. Consequently, negative values of C mean that the hearsay evidence favors H^c over H. This conclusion may seem unremarkable and, in a sense, it is. However, it is important to recognize that it implies that a hearsay report E^* may in fact make E^c rather than E more probable than it was previously. If E^c favors H^c (rather than H), the hearsay report of E favors H^c even though the event E, if known, favors H. If this conclusion is not counterintuitive, it is interesting, and we have more to say about it below in section 4.

2. The Credibility of the Hearsay Declarant

Consider the definition of the terms $h_1 = P(E^*_1|E)$ and $f_1 = P(E^*_1|E^c)$ in Equation 3 in Figure 8. These two terms are conditional probabilities. They refer to the likelihood of the primary witness (the hearsay declarant) telling the secondary witness (the courtroom witness) that E happened if, respectively, E did occur and E did not occur. Recall that the term E^*_1 represents the report by the primary witness to the secondary witness that E happened. Consequently, the terms h_1 and f_1 concern the credibility of W_1 when making the statement perceived by W_2.[46]

46. This means, of course, that any assessment of W_1's credibility involves an assessment of the attributes of veracity, objectivity, and sensory sensitivity,

Next, we must consider how the ingredients $h_1 = P(E^*_1|E)$ and $f_1 = P(E^*_1|E^c)$ affect the term C.

First, suppose that W_1 is truthful, objective, and accurate in his account of event E to W_2. If so, then we would expect $h_1 = P(E^*_1|E) > f_1 = P(E^*_1|E^c)$ by an amount indicated by the strength of our beliefs about these credibility attributes for W_1. To the extent that we have reasons to doubt any attribute of W_1's credibility, then either (a) $h_1 > f_1$ by a small amount or (b) $f_1 = P(E^*_1|E^c) > h_1 = P(E^*_1|E)$. For example, if we had reason to believe that W_1 lied to W_2 in telling him about E, then $f_1 > h_1$. As h_1 gets larger relative to f_1, C gets smaller; i.e., the more credible we believe W_1 to be, the smaller the term involving h_1 and f_1 becomes.

Second, suppose that we think that W_1 is not a credible witness; i.e., suppose that we believe that $f_1 > h_1$. If the size of f_1 increases relative to h_1, the term involving h_1 and f_1 in C becomes negative in value and approaches the value (-1). When $C = -1$, then $E^*_{2,1}$ favors H^c, not H. Taken by itself, therefore, the statement of W_1 depresses the probative significance of the event she was said to have reported.

In the third scenario, the values of h_1 and f_1 get close together. This scenario produces some interesting results. First, suppose $h_1 = 0.45$ and $f_1 = 0.44$. Their ratio is $45/44 = 1.023$. Now $[1.023 - 1]^{-1} = 1/(0.023) = 43.48$. This adds considerable inferential drag to term C and makes the hearsay evidence almost entirely worthless. Now reverse the values of h_1 and f_1; i.e., suppose $h_1 = 0.44$ and $f_1 = 0.45$. Their ratio now is 0.978, and, therefore, the term takes the value $[0.978 - 1]^{-1} = 1/(-0.022) = -45.454$. This negative term added into C also produces a large amount of inferential drag.

These results suggest that if the hit rate and the false positive rate for the primary witness (W_1) are close together—i.e., if hits and misses are approximately the same— the primary witness's statement to the secondary witness has little probative value. This conclusion is intuitive. If the primary witness's report to the secondary witness was as likely if E happened as if it did not, then the secondary witness's report of E to us cannot have much value.

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or accuracy of perception. In part IV.D., *infra*, we decompose the terms $P(E^*_1|E)$ and $P(E^*_1|E^c)$ to incorporate these credibility attributes. At this point, we consider the values $h_1 = P(E^*_1|E)$ and $f_1 = P(E^*_1|E^c)$ only in their undecomposed form.

3. The Credibility of the Courtroom Witness

Examine Equation 3 in Figure 8 again. Consider the inverse term involving h_2 and f_2. By definition, $h_2 = P(E^*_{2,1}|E^*_1)$, and $f_2 = P(E^*_{2,1}|E^*_1{}^c)$. The terms h_2 and f_2 involve the credibility of the secondary witness, the courtroom witness.[47] Our conclusions about the effect on C of the inverse term involving the primary witness's hit rate and false positive rate (i.e., h_1 and f_1) also apply to the effect of the inverse term involving the secondary witness's hits and false positives (i.e., h_2 and f_2). When h_2 is large relative to f_2, this term adds very little to C. When h_2 and f_2 are close together in value, the term adds a lot to C. When f_2 is large relative to h_2, a negative amount is added to C.

4. The Probative Value of Improbable Hearsay Declarations

We already have examined the impact of event rareness on the probative value of testimonial evidence. This problem now receives a different articulation. Consider the term $(h_1 - f_1)$. The ingredients of this term refer to the hit and false positive rate of the primary witness, or hearsay declarant. Within term C, there are two types of terms that involve the ingredients h_1 and f_1. One of them involves the ratio (h_1/f_1). The other involves the difference $(h_1 - f_1)$. Recall that ratios suppress rareness but that differences capture it. Observe that the inverse term involving h_2 and f_2 is divided by the difference term involving h_1 and f_1. This indicates that the credibility of the courtroom witness W_2 is weighted in a certain manner by the credibility of the hearsay declarant W_1. Hence, the credibility of the witnesses interact in a testimonial chain. Bayes' Rule portrays this interaction in a specific and interesting way.

Suppose that the courtroom witness W_2 is a marvel of credibility; i.e., we believe that $h_2 = 0.99$ and $f_2 = 0.01$. In this case the inverse term has the value $1/98 = 0.010$. Now suppose that while we believe that the probability of hits is much greater in the case of the hearsay declarant W_1, we also believe that, in the hearsay declarant's case, the probability of *either* hits or false positives is very low; i.e., while we believe that the hearsay declarant is much more likely to score a hit than a false positive, we also believe that she is not very likely to score either a hit or a false positive. Hence, suppose that $h_1 = 0.090$ and $f_1 = 0.001$.

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47. When assessing h_2 and f_2 for W_2, we would want to consider the veracity of W_2 and his other relevant testimonial attributes. For the time being, however, we are ignoring the ingredients of judgments about credibility.

The ratio of h_1 and f_1 is now 90/1. However, their difference is only 0.089. This means that we believe that W_1's report to W_2 is a rare event, or, alternatively, that it is inherently very improbable. W_1 is certainly credible, but for some reason we cannot see him telling W_2 that E occurred, whether or not it occurred. If 1/98 (for W_2) is divided by 0.089 (for W_1), the result is 0.112, which gets added to C. This addition to C goes a long way toward destroying the value of the hearsay from the courtroom witness W_2.

Consider some further variations. First, suppose that $P(E|H) = 0.90$ and $P(E|H^c) = 0.01$. Thus, event E is very probative of H. If we know for sure that E happened, we could move our opinion in the direction of H by a factor of 90:1. However, we only have W_2's hearsay evidence that W_1 said that E occurred. If we believe that $h_1 = 0.090$ and $f_1 = 0.001$, and that $h_2 = 0.99$ and $f_2 = 0.01$, then $C = 1/(90-1) + [1/(99-1)]/0.089 = 0.011 + 0.112 = 0.123$. With this C value, we can calculate L for $E^*_{2,1} = [(0.90) + 0.123]/[0.01 + 0.123] = 1.023/0.133 = 7.69$, a value much smaller than $L = 90$. This is an interesting result. Here the courtroom witness is very credible; the hearsay declarant also is very credible; and the event supposedly reported by the hearsay declarant has very substantial probative value if it actually happened. Nonetheless, the hearsay evidence given by the courtroom witness W_2 has smaller probative value. The reason for the lack of punch in W_2's testimony has to do with rareness. The hearsay evidence has little probative value because the hearsay declaration by W_1 is inherently very improbable, or rare. The testimony by W_1 has little probative value because the hearsay declaration by W_2 is very improbable, both if E did occur and if E did not occur.

5. Summary

Bayes' Rule says that judgments about the probative value of hearsay evidence involve five ingredients when judgments about the credibility of a single witness are treated as primitive—when, therefore, more discrete testimonial attributes such as ability to perceive and veracity are ignored. The examples in Table 1 illustrate how "hearsay logic" works when judgments about credibility remain undecomposed.[48]

In all fourteen examples in Table 1, the reported event E is probatively important; L_E in each of these cases is 90/1. How-

48. When E is rare, however, W_2's report offers less support for E^c. (Here, L [rare] = 1/0.911 = 1.098, favoring H^c).

ever, alternative assumptions are made about the absolute probability of the reported event E. Two following cases are considered: (1) P(E|H) = 0.90 and P(E|H^c) = 0.01, i.e., E is not a rare or improbable event; and (2) P(E|H) = 0.09 and P(E|H^c) = 0.001, i.e., E is a rare, or improbable, event.

TABLE 1

Case	h_1	f_1	h_2	f_2	C	L	L [rare]
1	0.999	0.001	0.999	0.001	0.002	75.17	30.67
2	0.0999	0.0001	0.999	0.001	0.011	43.38	8.42
3	0.999	0.001	0.0999	0.0001	0.002	75.17	30.67
4	0.81	0.80	0.999	0.001	80.1	1.01	1.001
5	0.999	0.001	0.81	0.80	−81.16	0.989	0.999
6	0.001	0.999	0.999	0.001	−1.002	.103	0.911
7	0.999	0.001	0.001	0.999	−1.002	.103	0.911
8	0.001	0.999	0.001	0.999	0.002	75.17	30.67
9	0.200	0.201	0.7	0.1	−367.67	0.998	0.999
10	0.200	0.201	0.200	0.201	200,799.00	1.000	1.000
11	0.8	0.4	0.8	0.4	3.5	1.25	1.025
12	0.8	0.1	0.8	0.1	0.347	3.493	1.256
13	0.9	0.09	0.9	0.09	0.248	4.450	1.357
14	0.8	0.04	0.8	0.04	0.122	7.742	1.274

Columns 2-5 of Table 1 show the ingredients of C. The calculation of the value of C on the basis of these ingredients is shown in Column 6. Column 7 shows the likelihood ratio for W_2's hearsay testimony when E is not rare [L]. Column 8 shows the likelihood ratio for W_2's hearsay testimony when E *is* rare [L rare].

Case 1 shows that hearsay testimony about event E from two nearly perfect witnesses can have nearly the same probative significance as certain knowledge of event E—*unless* E is a rare event. If E is a rare event, its probative force is reduced by over half—even though the two witnesses in the hearsay chain have very strong testimonial credentials. In Case 2, the out-of-court declarant W_1 is still very credible, but we believe his *telling* the courtroom declarant W_2 about event E is a rare event, or very improbable. The improbability of W_1's statement to W_2 reduces the value of W_2's report of W_1's statement in any case, but the probative value of the hearsay declarant's (W_1's) report is practically annihilated when we believe that the reported event, E, also is rare.

Cases 11-14 show that the probative value of hearsay grows gradually as the h/f ratio for each witness increases. The ratios in these four cases are 2:1, 8:1, 10:1, and 20:1. The probative value of the hearsay evidence does not increase in direct proportion to the increase in the h/f values. Thus, increases in the probative value of hearsay evidence are not directly proportional to increases in the credibility of the two witnesses taken separately.

The next group of cases illustrates how the probative value of hearsay evidence is weakened when the hits and false positives for one or both witnesses are about the same; i.e., when one or both of the witnesses is about as likely to say that something happened when it did not happen as when it did. In Case 4, the hearsay declarant W_2 is almost equally likely to tell the courtroom witness W_2 that E happened whether it did or not. This destroys the probative value of the hearsay evidence. The rareness of E is immaterial. In Case 9, the hearsay declarant W_1 again is almost as likely to tell W_2 that E occurred when it did not in fact occur as he is to say that E occurred when it did occur, but here the courtroom witness is moderately credible. The result is essentially the same as in Case 4: the value of the hearsay is destroyed. In Case 5, the hearsay declarant, W_1, is extremely credible, but we believe it is extremely probable that W_2 would report the hearsay statement whether or not he actually received a report from W_1. This almost annihilates the probative value of this hearsay. The rareness of E again is immaterial. In Case 10, both witnesses are almost as likely to make their reports if the events they reported did *not* occur as they are if the events they reported *did* occur. The result is that the hearsay evidence has almost no probative value. Once again, it is immaterial whether the event E is rare.

The results in the foregoing cases probably conform to common intuition. The results in the next three cases, however, are less obvious and challenge both intuition and Bayesian theory. All of these cases involve reverse inferential spin; i.e., they involve situations in which a report of E strengthens the inference E^c, or not-E. In Case 6, the courtroom witness W_2 is very credible, but the hearsay declarant W_1 is a liar. Bayes' Rule says that W_2's report offers some support for E^c rather than E. (The value $L = 0.103$ means that the hearsay report favors H^c in the ratio $1/0.103 = 9.708$). In Case 7, the courtroom witness W_2 is a liar, and the hearsay declarant W_1 is a saint. The probative force of the hearsay evidence is the same as in Case 6.

Case 8 is the most interesting of the lot. The hearsay declarant W_1 and the courtroom witness W_2 both are liars. The values of h_1 and f_1 say that the hearsay declarant W_1 is 999 times more likely to tell the courtroom witness W_2 that E happened if E did not happen than if it did. The values of h_2 and f_2

say that the courtroom witness W_2 is 999 times more likely to tell the trier of fact that the hearsay declarant W_1 asserted E when W_1 did not assert E than when W_1 did, in fact, assert E. The striking result of these assumptions is that the hearsay evidence in this case has as much probative value as it does in Case 1 where the credibility of both the courtroom witness and the hearsay declarant is very good. Can it be that the hearsay evidence in Case 8 has substantial probative force even though both the hearsay declarant and the courtroom witness are liars, and can it be that the hearsay evidence can be just as probative as it is when they are both saints? Or is Case 8 an anomaly that demonstrates that there is something wrong with a Bayesian interpretation of hearsay logic?

A distinction can be made that partially obviates the apparent anomaly in Case 8. $E^*{}_1{}^c$ is the event that W_1 did not report E to W_2. This means either that (a) W_1 told W_2 that E did not happen, or (b) W_1 did not say anything at all to W_2. In situation (a), Bayes' Rule makes perfect sense. If W_2 is lying, W_1 told him that E did not occur. If, in turn, W_1 is lying, E did occur. As our earlier discussion of testimonial credibility implies, we can believe E even though both witnesses are lying.

Suppose, however, that W_1 did not say anything about E to W_2. How can we assign a large probative value to a hearsay report about E that W_2 made up? In this case, W_2 has put words into W_1's mouth. It seems that a Bayesian interpretation of the probative value of hearsay evidence produces an anomaly after all. The anomaly is partly real, but it also is partly apparent because missing evidence still is evidence; i.e., W_1's failure to say anything to W_2 may be probative in and of itself. Under the axioms of conventional probability theory, if $P(E^*{}_1|E) = 0.001$, then $P(E^*{}_1{}^c|E) = 0.999$. If E is "W_1's failure to say anything about E to W_2", the probability of W_1's not telling W_2 that E happened, if E did happen, is 0.999. Thus, it is possible that E happened without W_1 telling W_2 about it. Furthermore, ancillary evidence may support the judgment that there is a high probability that W_1 would withhold evidence about E from W_2 if event E did occur.

Although missing evidence may have evidentiary value, it is still difficult to accept giving strong probative value to a hearsay statement that the courtroom witness simply "made up." The two-liars hearsay problem shows the need for further refinement of the Bayesian interpretation of testimonial and hearsay evidence that we have presented. Specifically, the two-liars problem highlights our assumption that a signal has been received. The absence of an information-carrying signal—i.e., the absence of any relevant observation by a witness—is not probative of $\{H,H^c\}$. It is obviously possible that no signal was received, or that no relevant observation was made.

When evaluating testimonial or hearsay evidence, it is clearly important to take into account any significant uncertainty about whether a relevant observation was made. No inherent obstacle prevents the accommodation of this uncertainty in a Bayesian framework, and, later in this Article, we shall make some suggestions about how this might be accomplished.[49] Moreover, even in the absence of further analytical refinement, the two-liars hearsay problem is instructive. The solution of the problem in Case 8 holds; if the judgment is made that an information-carrying signal was indeed sent and received, a trier of fact may believe not-E, and therefore, not-H. This is true even though E by itself supports H and the courtroom witness reports that the hearsay declarant said E. Bayesian analysis thus confirms the epistemological point we made earlier. A trier of fact can and should give her own "twist" to any testimonial evidence she sees. Testimonial evidence can and should be viewed as an event. A testimonial event may have an inferential and probative significance for the trier of fact that it does not have or was not intended to have by the actors who made the testimonial event happen.

The discussion of testimonial attributes in the next section further decomposes the factors that influence judgments about whether and how far a decision maker should infer E on the basis of a report of E^c. However, the point that a trier of fact can and should give her own "twist" to a testimonial report when she believes that she has observed a relevant signal remains both valid and fundamental. This principle holds as long as the law expects the trier of fact to use her own judgment about the evidence she observes rather than simply accept the judgments of the witnesses she sees and hears.

C. Hearsay and Conditional Nonindependence

All of our formal discussions of hearsay logic in this part of the Article have addressed only a single series of inferences about hearsay evidence. Now, however, we consider cases in which credibility-relevant attributes and behavior of a witness

49. The possibility of the absence of an information-carrying signal may be accommodated by a more refined partition of the event classes in a hearsay inference structure. *See infra* part IV.D.

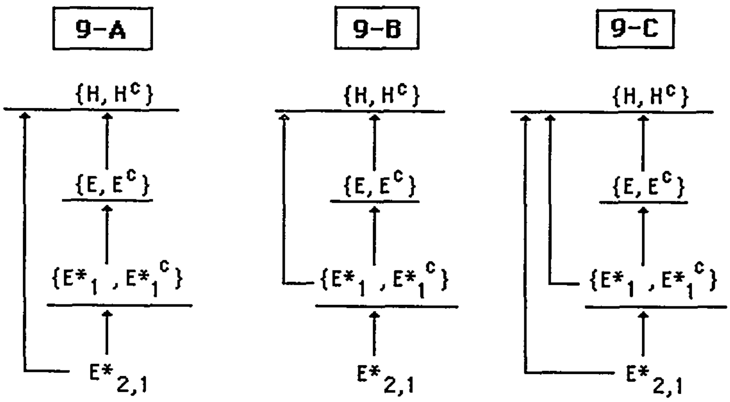


FIGURE 9

are directly connected with the fact or facts in issue. Figure 9 portrays three such cases. In the parlance of Bayesian theory, the three cases in Figure 9 are instances in which the inference structure is characterized by conditional nonindependence. Conditional nonindependence is an interesting and important phenomenon. When conditional independence holds, the probative value of the hearsay from the courtroom witness never can exceed that of the known occurrence of an event E reported by a witness. When conditional nonindependence occurs, however, there can be more probative value in the hearsay than there is in the event asserted by a hearsay declarant. In fact, when there is conditional nonindependence, the likelihood ratio for testimony has no bounds; it can go to infinity in one direction and zero in the other. (Remember that a zero likelihood ratio means that the testimony is conclusive on H^c). The reason for these seemingly odd phenomena is that the credibility-relevant behavior of the secondary source is itself probatively significant.

Figure 9 contains several examples of conditional nonindependence in reasoning chains involving hearsay evidence. In the case shown in Figure 9-A, the testimony of the courtroom witness is conditional upon ultimate probanda $\{H,H^c\}$ as well as upon (E^*_1,E^{*c}_1), the assertion or absence of an assertion by the hearsay declarant. The conditional nonindependence involved here concerns the fact that either or both of the following inequalities hold: (i) $P[E^*_{2,1}|E^*_1 \& H] \neq$

$P[E^*_{2,1}|E^*_1]$, and (ii) $P[E^*_{2,1}|E^*_1 \& H^c] \neq P[E^*_{2,1}|E^*_1]$. In short, the courtroom witness' testimony depends not only upon what the hearsay declarant said (or didn't say), but also upon whether H or H^c is true. For example, suppose H represents "guilty," and H^c, "innocent." The h and f values assigned to the courtroom witness's testimony depend to some degree on whether the defendant's innocence is assumed.

We might conclude that the courtroom witness's credibility is affected by the facts in issue—H or H^c—if we believe that the courtroom witness knows more than he is telling us; i.e., if he has acquired some knowledge about H or H^c but is not explicitly disclosing that knowledge. Indeed, the courtroom witness might know whether H is true. Although the courtroom witness is not explicitly disclosing his knowledge of H and H^c, we may be able to infer something about the facts in issue from the behavior of the courtroom witness.

Figure 9-B depicts a situation in which the credibility-relevant behavior of the *hearsay declarant* is conditional not only upon whether event E occurred—i.e., the event she allegedly reported to the courtroom witness—but also upon whether H is true. Here we have one or both of the following inequalities holding: (i) $P[E^*_1|E \& H] \neq P[E^*_1|E]$, and (ii) $P[E^*_1|E \& H^c] \neq P[E^*_1|E]$. The third case is shown in Figure 9-C. In that case, the credibility-relevant behavior of both witnesses is conditional upon H or H^c.[50]

The box in Figure 10 shows an equation for the probative force of hearsay where credibility is conditioned by H or H^c.[51] The equation shown in Figure 10 has ten variables or parameters. In sensitivity analysis, some of these parameters are fixed while others are varied, thereby showing how the equation behaves in response to variation in its ingredient parameters. Table 2 summarizes the results of one such "experiment."

50. Other patterns of conditional nonindependence are possible. These involve the events $\{E,E^c\}$. The courtroom witness's credibility-relevant behavior may be conditional upon whether or not event E occurred. This can happen in addition to this witness's credibility-relevant behavior being conditional upon H or H^c.

51. This equation takes credibility in its undecomposed form, and it ignores possible conditioning by E or E^c of the credibility of the courtroom witness.

GENERAL EQUATION:

$$\Lambda_{E^*_{2,1}} = \frac{p_1\,[q_1 - r_1][s_1 - t_1] + r_1\,[s_1 - t_1] + t_1}{p_2\,[q_2 - r_2][s_2 - t_2] + r_2\,[s_2 - t_2] + t_2}$$

Where:

$p_1 = P(E \mid H)$	$p_2 = P(E \mid H^c)$
$q_1 = P(E^*_1 \mid EH)$	$q_2 = P(E^*_1 \mid EH^c)$
$r_1 = P(E^*_1 \mid E^c H)$	$r_2 = P(E^*_1 \mid E^c H^c)$
$s_1 = P(E^*_{2,1} \mid E^*_1 H)$	$s_2 = P(E^*_{2,1} \mid E^*_1 H^c)$
$t_1 = P(E^*_{2,1} \mid E^{*c}_1 H)$	$t_2 = P(E^*_{2,1} \mid E^{*c}_1 H^c)$

FIGURE 10

TABLE 2

Case	p_1	q_1	r_1	s_1	t_1	p_2	q_2	r_2	s_2	t_2	$LE^*_{2,1}$
1	.9	.75	.01	.99	.01	.05	.75	.01	.99	.01	12.0
2	.9	.75	.01	.99	.01	.05	.74	.01	.009	.001	672.0
3	.9	.75	.01	.99	.01	.05	.009	.001	.99	.01	61.09
4	.9	.75	.01	.99	.01	.05	.009	.001	.009	.001	672.0
5	.9	.75	.01	.01	.99	.05	.75	.01	.99	.01	5.86
6	.09	.075	.001	.099	.001	.005	.075	.001	.009	.001	1.55
7	.9	.75	.01	.9	.7	.05	.75	.01	.99	.01	14.91
8	.9	.75	.01	.99	.01	.05	.75	.01	.9	.7	1/1.05$[H^c]$
9	.9	.9	.7	.99	.01	.05	.75	.01	.99	.01	5.57
10	.9	.01	.75	.01	.99	.05	.75	.01	.99	.01	16.21
11	.9	.5	.5	.001	.99	.05	.75	.01	.99	.01	8.93
12	.9	.5	.5	.99	.01	.05	.75	.01	.99	.01	8.93
13	.09	.5	.5	.99	.01	.005	.75	.01	.99	.01	21.74
14	.9	.25	.24	.25	.24	.05	.75	.01	.99	.01	4.32
15	.9	.5	.5	.99	.01	.05	.5	.01	.99	.01	1.0
16	.9	.9	.9	.99	.01	.05	.9	.5	.99	.01	1.0
17	.9	.75	.01	.9	.9	.05	.75	.9	.9	.9	1.0
18	.9	.9	.9	.9	.9	.05	.75	.01	.99	.01	16.07
19	.9	.75	.01	.99	.01	.05	.01	.01	.01	.99	2.30
20	.9	.75	.01	.001	.0005	.05	.75	.75	.9	.7	1/1082.8$[H^c]$
21	.9	.25	.24	.001	.0005	.05	.25	.01	.9	.7	1/1197.0$[H^c]$
22	.09	.25	.24	.001	.0005	.005	.25	.24	.9	.7	1/1206.5$[H^c]$
23	.9	.99	.01	.99	.01	.05	.25	.24	.25	.24	3.65
24	.9	.25	.24	.25	.24	.05	.99	.01	.99	.01	3.57
25	.9	.5	.5	.99	.01	.05	.99	.01	.5	.5	1.0

Some of the ingredients in the general equation in Figure

10 are more interesting than others. For example, we already know that the probative significance of the event asserted in the hearsay is important in determining the probative significance of the hearsay testimony about this event. Hence, in Table 2, we have "fixed" the probative significance of event E, the event reported in hearsay testimony by the courtroom witness. In all of the examples in Table 2, event E has a likelihood ratio of 18; i.e., event E is 18 times more probable under H than under H^c. In every case, $L_E = P(E|H)/P(E|H^c) = p_1/p_2 = 18$, but this ratio is obtained in two conditions: (i) when $p_1 = 0.9$ and $p_2 = 0.05$, and (ii) when $p_1 = 0.09$ and $p_2 = 0.005$. In the latter case, event E is a "rare" event. All other ingredients concern the credibility of the primary and secondary witnesses: q and r ingredients are for the hearsay declarant, and s and t ingredients are for the secondary witness.

Although we cannot discuss all of the results shown in Table 2, we do wish to note that some of the results illustrate the dramatic impact that conditional nonindependence can have on the probative value of hearsay evidence. Consider Case 2. In that case, both witnesses have good credibility credentials, but the credibility of the courtroom witness is different under H than it is under H^c. In fact, the courtroom witness is violently biased against giving this testimony if H^c is true; i.e., his testimony is very improbable whether or not the primary source told him that E happened. On these assumptions, $L_E{}^*{}_{2,1} = 672$. Thus, hearsay under these conditions is 37 times more probatively valuable than knowing event E for sure!

Consider also Case 7. There the courtroom witness has a bias conditional upon H. Recall that there are different kinds of bias. Here the courtroom witness's hearsay testimony is very probable whether or not the hearsay declarant reported the event E to the courtroom witness; the courtroom witness's bias is in favor of testifying that E happened. In this situation, $L_E{}^*{}_{2,1} = 14.91$. Thus, the courtroom witness's testimony has a respectable degree of probative value. Normally a bias in favor of giving testimony destroys its value. Here, however, the courtroom witness's testimony is conditional upon the hypotheses, and it therefore acquires additional probative value.

Case 20 is both complex and curious. In Case 20, the courtroom witness has a strong bias against reporting the hearsay when H is true, but the courtroom witness is biased in favor of reporting the hearsay when H is not true. The result is a whopping likelihood ratio favoring H not being true, $L_E{}^*{}_{2,1} = 1/1082.8$. If we knew for sure that E did not occur, we would move our opinions in the direction of H^c by a factor of 9.5.[52] Hence, the hearsay in Case 20 has 1082.8/9.5 = 114 times more probative value than knowing E^c for sure. This result may seem odd. But it is not. In Case 20, the behavior of the courtroom witness is probative. The probative value of the hearsay is much greater than the known occurrence E^c simply because the witness's behavior is extremely probative: we believe he would very likely exhibit different types of behavior depending upon whether we believe H or not-H to be true.

D. Hearsay and Testimonial Attributes

We have not yet attempted a comprehensive Bayesian analysis of the relationship in hearsay argument between testimonial attributes, credibility, and probative value.[53] Thus, we have no formal results to report for hearsay argument in which credibility judgments are decomposed. We do have, however, some further observations about the phenomenon of the value of liars and other unreliable witnesses.

We indicated earlier that proper analysis of the testimony of liars and unreliable witnesses requires a distinction between witnesses who made a relevant observation and those who did not. This distinction also must be incorporated into any formal analysis of a testimonial chain that may include liars or other kinds of unreliable witnesses; the possibility that the courtroom witness W_2 did not observe a hearsay statement by the hearsay declarant W_1 must be taken into account. The inference tree in Figure 11 shows how this distinction may be expressed.

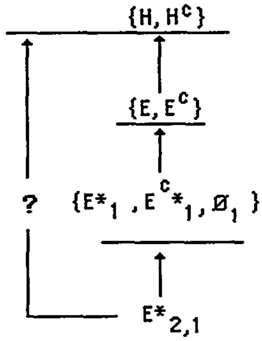
Figure 12-A shows a fine-grained decomposition of hearsay in terms of the testimonial attributes of both witnesses. The reasoning chain shown in Figure 12-A is based on the binary event classes that we used in earlier portions of this Article. When the reasoning chain is modified to take into account the possibility that no relevant observation was made either by W_2 or W_1 or by both, the reasoning chain takes the form shown in Figure 12-B.

V. HEARSAY HEURISTICS

Hearsay problems are subtle. Argument about hearsay evi-

52. When $P(E|H) = 0.9$ and $P(E|H^c) = 0.05$, we know that $L_E = 18$. And L_{E^c}—the probative value of knowing E^c for sure—is $L_{E^c} = P(E^c|H)/P(E^c|H^c) = [1 - P(E|H)]/[1 - P(E|H^c)] = 0.10/0.95 = 1/9.5$, favoring H^c.

53. Our analysis of hearsay thus far deals only with undecomposed credibility judgments.



NOTE:

E^*_1 = Primary witness told secondary witness that event E occurred.

$E^{c}*_1$ = Primary witness told secondary witness that event E did not occur.

$\emptyset_1$ = Primary witness said nothing about event E to the secondary witness.

FIGURE 11

dence depends on minute variations in detail, and minute changes in hearsay evidence or the surrounding circumstances can have a dramatic effect on argument about hearsay. Hearsay problems also are so complex that they threaten to outstrip our capacity to calculate the probative force of even a single real-world piece of hearsay evidence. The complexity of hearsay problems therefore presents a challenge to the goal of orderly and logical analysis of hearsay evidence.

Is it possible to conduct real-time analyses of real-world hearsay problems? The answer is both "yes" and "no." The answer is "no" if the question is whether it is possible to dissect and analyze every conceivable detail and nuance that may affect argument and judgment about hearsay evidence. The answer may be "yes" if we think of "analysis" of hearsay—i.e., orderly and explicit argument about hearsay—not as a procedure for mechanical solutions to our questions about hearsay, but as a heuristic device for exploring, mapping, and checking our own thinking about hearsay evidence. If we see analysis in this latter mode, it may not be necessary to take into account every detail that might have an effect on our judgments, but only those details that seem important.

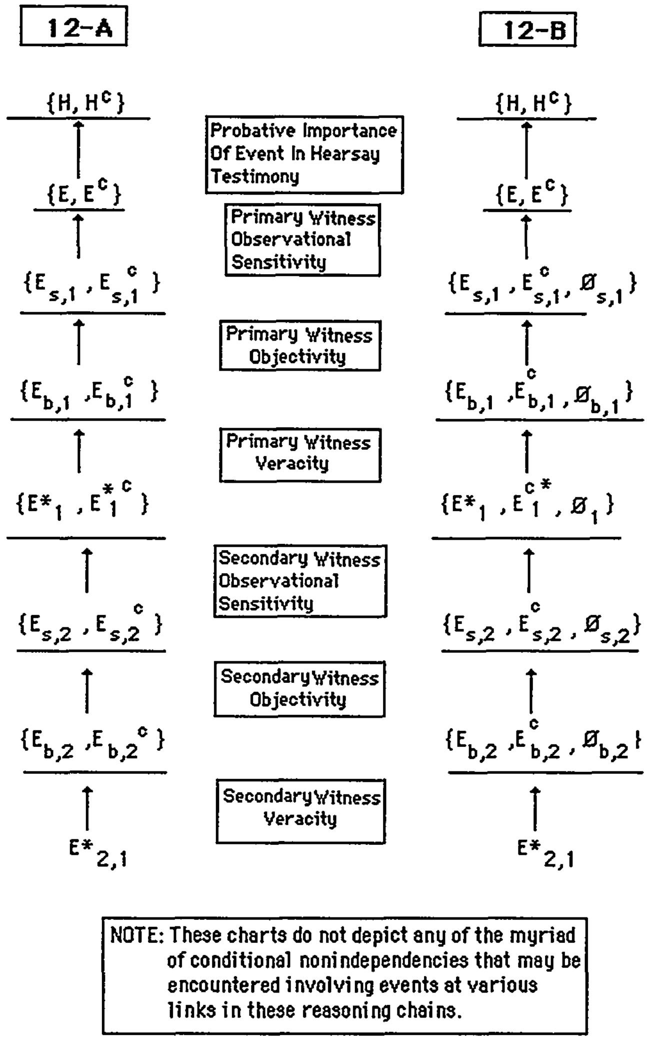


FIGURE 12

Nuances and details, however, do matter. Even if we limit ourselves to the nuances and details that seem important, the question remains whether we can consider them in an orderly and logical way. It is important to frame this question in the right way. If the question is, "Do we fully understand hearsay logic?," the answer is clearly "no." This, however, is not the question we have in mind. The question we are asking is whether it is useful to argue about hearsay evidence in an orderly and logical manner. In considering this question, it is important to remember that the alternative to orderly analysis of hearsay problems is disorderly analysis of hearsay problems or no analysis at all. It is hard to swallow the proposition that we are better off if we do not reason about hearsay problems.

It is possible to reason in an orderly way about particular parts or features of a hearsay problem, and it is possible to reason about a hearsay problem in an orderly way without pursuing or seeing all of the consequences of one's assumptions and judgments. Logical analysis should not be thought of as a machine that digests the ingredients of hearsay problems and then spits out solutions, but as a tool that illuminates the properties of our natural thinking more fully. If we trust our natural thought processes, we need not despair that we do not have the time or the ability to make fully explicit every feature of our natural way of thinking about problems of evidence and hearsay evidence. Our natural way of thinking about hearsay is probably not so inappropriate. In any event, we have no satisfactory alternative to our natural, or ordinary, way of thinking about hearsay. Orderly thinking may make our natural thinking work better.

Although incomplete logical argument about hearsay evidence is better than no argument at all, we have said little about which heuristic strategy is appropriate for attacking hearsay problems.[54] We cannot say for sure what sort of strategy for the efficient deployment of cognitive resources is likely to be most fruitful. We can say, however, that the law's strategy for dealing with hearsay is interesting and may have intrinsic heuristic merit.

To the extent that the hearsay rule is a rule for the organization of cognitive work, the hearsay rule requires that judges and lawyers distinguish two types of out-of-court utterances. The American law of evidence stipulates that out-of-court utterances are either hearsay or non-hearsay. It then proclaims that if an out-of-court utterance is hearsay, the judge and the lawyer must examine the testimonial credentials of the hearsay declarant. American law also proclaims that if an out-of-court

54. It is important to have a strategy. Limitations of time and resources force us to ignore some relevant features of the hearsay problem at hand while attending to others, but it is important to attend to the set of features that is more likely than another set in order to shed significant light on the problem at hand.

utterance is viewed as non-hearsay, the participants in the analytical process—the judge and the lawyers—must focus their attention on the way that the utterance connects with the fact or facts in issue without regard to the credibility of the hearsay declarant. This quite possibly is a sound way of organizing scarce cognitive resources when the question of the admissibility of an out-of-court utterance arises.

The law's distinction between hearsay utterances and non-hearsay utterances parallels our own distinction between two types of inferential claims: first, inferential chains whose base consists only of judgments and arguments about credibility and testimonial attributes, and second, inferential chains in which there are "direct" or "lateral" links between utterances, credibility, or testimonial attributes and the fact or facts in issue. The legal distinction between hearsay and non-hearsay thus parallels a fundamental theoretical distinction. Of course, this parallel does not in itself demonstrate that it is wise to use the distinction to regulate the deployment of scarce cognitive resources in arguments about the admissibility and value of hearsay evidence. We went to some trouble, after all, to show that testimonial attributes may be linked both "vertically" and "laterally" to facts in issue; e.g., testimonial attributes may be linked to a fact in issue by the medium of credibility, and, at the very same time, they may be linked directly to a fact in issue.

In view of the possibility that a hearsay problem will involve both vertical and lateral reasoning chains, may anything be said in favor of a procedure whereby an advocate begins either with an analysis of a "vertical" link or with an analysis of a "lateral" link, but not both together at once? We cannot say for sure. We can say, however, that it is possible that judges and lawyers somehow have an intuitive ability to see when a potential hearsay problem depends primarily on judgments about credibility and testimonial attributes and when a statement raises questions primarily about direct connections between the facts in issue and out-of-court utterances or attributes of the witnesses.

If it is true that judges and lawyers have the intuitive ability to see when "hearsay is hearsay" and when apparent hearsay really is non-hearsay, the law's way of structuring the deployment of cognitive resources may be efficient. Of course, the use of this simplifying strategy exacts a price; it is always possible that the intuition of the lawyer or the judge will be wrong or that the probative value of an out-of-court utterance will indeed depend on both vertical and lateral links. However, a price is exacted by any cognitive strategy. The question becomes, "How large is that cost in comparison with the benefits?" It is entirely possible that a "black-letter" approach to the analysis of hearsay problems is an efficient strategy. In any event, that seems to be the law's judgment. The occasional errors of black-letter classification of out-of-court utterances, it is thought, are worth the cognitive economy achieved by the use of coarse categorizations of different types of out-of-court utterances.

Even if it is admitted that coarse classifications of hearsay are necessary, it might be argued that the law's tacit substantive judgments about the worth or value of various categories of out-of-court utterances are not justified. For example, it might be argued that our own analysis suggests that the law errs in supposing that hearsay statements are probative if and only if at least some of the testimonial attributes of the hearsay declarant are shown to be (relatively) good. The law's proclamation of such principles may, in fact, be in error. However, if the law errs in making such stipulations about the treatment of hearsay evidence, this cannot be extracted solely from the arguments made in this Article. The hearsay logic that we describe does not substantiate these or other conclusions about the rationality of the law's treatment of hearsay evidence. At most, our analysis provides some of the necessary analytical machinery for sound and informative *argument* about legal treatment of hearsay evidence. We reiterate that legal rules and principles that place hearsay evidence into broad categories for purposes of admissibility are not necessarily irrational.[55] It is true that legal

55. It may seem that our theory of hearsay logic implies that the admissibility of hearsay evidence should be decided on an individual basis—that each instance of hearsay evidence should be evaluated on its own. The notion that judgments about the probative value and admissibility of hearsay should be individualized is a popular one among academics. *See, e.g.*, Friedman, *supra* note 5, at 691 (arguing that the rigid definitional approach of the Federal Rules of Evidence does not work well); Jack B. Weinstein, *Probative Force of Hearsay*, 46 IOWA L. REV. 331, 355 (1961) (advocating conversion of hearsay rule from one of exlusion into one of discretion); Irving Younger, *Reflections on the Rule Against Hearsay*, 32 S.C. L. REV. 281, 293 (1980) (noting that there is no rule against hearsay, but only against unreliable evidence). We reserve judgment, however, about the wisdom of requiring judges to make individualized judgments of probative value when considering the admissibility of hearsay. Although we decidedly believe that the probative value of hearsay depends on a practically infinite variety of evidentiary details, and that the probative value of different instances of the same type of hearsay varies widely, we are not unmindful of the fact that considerations such as administrative convenience

principles, such as those that exclude "ordinary" hearsay statements, are insensitive to details that might dramatically alter or even reverse the probative value of the out-of-court statements that such principles cover. However, this fact alone does not show that coarse legal categorizations are irrational or that any particular coarse legal categorization is irrational, inefficient, or unwise. Coarse principles sometimes are an appropriate response to hard and subtle problems. We do not always have the time to reason as carefully as we would like. Principles that incorporate coarse categories amount to rules of thumb. A rule of thumb is sometimes an efficient strategy for dealing with otherwise intractable complexity and subtlety.

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must be taken into account. *See* Roger Park, *A Subject Matter Approach to Hearsay Reform*, 86 MICH. L. REV. 51, 62-67 (1987) (discussing various considerations for retaining hearsay rules). *But see* Christopher B. Mueller, *Post-Modern Hearsay Reform: The Importance of Complexity*, 76 MINN. L. REV. 367, 396-97 (1992) (Mueller discounts the argument that lawyers need hearsay rules because lawyers preparing for trial need to "know what they are up against." Mueller argues that it is "not clear that judges will perform better without [hearsay] rules to apply" because "even discretionary rules will produce doctrinal complexity."). Moreover, the problem of analytical complexity must be taken into account. If full analysis of the probative value of each piece of hearsay evidence is not possible, coarse categorizations of hearsay evidence may be the most sophisticated way of dealing with hearsay admissibility problems.