ARE PEOPLE PROBABILISTICALLY CHALLENGED?

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THINKING, FAST AND SLOW. By *Daniel Kahneman*. New York: Farrar, Strauss and Giroux. 2011. Pp. 3, 418. Cloth, $30; paper, $17.

INTRODUCTION

Daniel Kahneman's[1] recent book, *Thinking, Fast and Slow*, is a must-read for any scholar or policymaker interested in behavioral economics. Behavioral economics is a young, but already well-established, discipline that pervasively affects law and legal theory.[2] Kahneman, a 2002 Nobel Laureate, is the discipline's founding father. His pioneering work with Amos Tversky and others challenges the core economic concept of expected utility, which serves to determine the value of people's prospects.[3] Under mainstream economic theory, the value of a person's prospect equals the prospect's utility upon materialization (U) multiplied by the probability of the prospect materializing (P).[4] When the prospect is advantageous, its utility is a positive sum that augments the person's well-being. When the prospect is disadvantageous, its utility is a negative sum (a disutility) that decreases the person's well-being. Under both scenarios, the full amount of the person's utility or disutility is discounted by the prospect's probability of

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1. Daniel Kahneman is a Senior Scholar and a Professor of Psychology and Public Affairs, Emeritus, Woodrow Wilson School of Public and International Affairs, Princeton University, and the Eugene Higgins Professor of Psychology, Emeritus, Princeton University.

2. *See* Russell Korobkin, *What Comes After Victory for Behavioral Law and Economics?*, 2011 U. ILL. L. REV. 1653, 1653–56 (describing the pervasive effect of behavioral economics on legal theory and claiming that "the battle to separate the economic analysis of legal rules and institutions from the straightjacket of strict rational choice assumptions has been won" (footnote omitted)); Amanda P. Reeves & Maurice E. Stucke, *Behavioral Antitrust*, 86 IND. L.J. 1527, 1528–31 (2011) (underscoring the mainstream status of behavioral economics and criticizing neoclassical economists' refusal to incorporate behavioral inputs in their analyses of antitrust problems).

3. For an excellent summary of this work, see Daniel Kahneman, *Maps of Bounded Rationality: Psychology for Behavioral Economics*, 93 AM. ECON. REV. 1449 (2003).

4. For a foundational account of expected utility, see JOHN VON NEUMANN & OSKAR MORGENSTERN, THEORY OF GAMES AND ECONOMIC BEHAVIOR 15–29 (2d ed. 1947).

not materializing. Economic theory holds that the expected-utility formula, $P \cdot U$, ought to determine a rational person's choice among available courses of action. The action yielding the highest expected utility is the one that the person ought rationally to prefer over the alternatives.

This normative assumption underlies all economic models that predict human behavior. For example, when a legal system apprehends 10 percent (0.1) of all drivers who run a red light and forces each violator to pay a $300 fine, the expected fine for each prospective violator equals $30. Economic theory consequently predicts that a risk-neutral driver will run a red light when her expected gain from doing so exceeds $30. Hence, when the average social loss from a red-light violation (including the marginal increase in society's cost of enforcing the law) exceeds $30, economically minded scholars and policymakers recommend upping the fine to a sum that will eradicate the drivers' antisocial incentive to violate.[5]

Kahneman and his collaborators have carried out numerous experiments that examined people's determinations of probability and utility. These experiments purport to identify a systematic mismatch between the $P \cdot U$ formula and the ways in which people typically make decisions in the real world. Specifically, the experiments have been interpreted as demonstrating that people systematically err in calculating probability and appraising utility. According to Kahneman and other behavioral economists, these errors manifest people's bounded rationality.[6]

As far as probability is concerned, people often seem to allow familiar and stereotypical scenarios to override statistical information (pp. 112–13, 119–23, Chapter Twelve). They ignore general statistical information—specifically, they ignore "base rates" (pp. 146–69)—which causes them to underestimate the probability of unfamiliar events (pp. 149–53) and overestimate the probability of scenarios that fall within their experience or easily come to mind, such as natural disasters or startling events that have occurred recently (Chapter Thirteen). In the domain of utility, people fare no better. They irrationally allow their choices to be influenced by the framing of future prospects as either "gains" or "losses" (Chapter Twenty-Six). Specifically, the average person strongly prefers the prospect of not losing a certain amount of money to an equally probable prospect of gaining the same amount of money.[7] This preference explains people's loss aversion[8] and their unwillingness to sell property that they already own at what should be an economically attractive price (the "endowment effect").[9] Additionally, people's actions are often

5. *See* Alex Stein, *The Flawed Probabilistic Foundation of Law and Economics*, 105 Nw. U. L. Rev. 199, 200–01 (2011).

6. Pp. 412–14. The "bounded rationality" concept originates from Herbert A. Simon, Administrative Behavior (4th ed. 1997). *See, e.g.*, Bryan D. Jones, *Bounded Rationality*, 2 Ann. Rev. Pol. Sci. 297, 302 (1999).

7. Pp. 278–83. *See generally* A. Peter McGraw et al., *Comparing Gains and Losses*, 21 Psychol. Sci. 1438 (2010).

8. Pp. 283–86; *see also* McGraw et al., *supra* note 7, at 1443.

9. Chapter 27. *See generally* Daniel Kahneman et al., *Experimental Tests of the Endowment Effect and the Coase Theorem*, 98 J. Pol. Econ. 1325 (1990) (showing that the

driven by sunk costs—expenses that have already been incurred, and that an economically rational individual ought to ignore.[10]

These findings regarding bounded rationality have a far-reaching implication: they prompt policymakers and scholars to abandon the neoclassical *homo economicus* assumption used to predict people's choices and evaluate the effects of policy interventions.[11] Kahneman argues that scholars and policymakers would do well to shift their attention to the ways in which typical real-world people appraise probability and utility. These ways, according to Kahneman, exhibit misjudgments that are potentially harmful to the person making a decision and anyone else who depends on her decision.

These findings have won many adherents among legal scholars.[12] Their broad acceptance in the legal academy has led to the establishment of the discipline of Behavioral Law and Economics.[13] Scholars working in this discipline use these findings as a basis for recommending a variety of legal reforms: the mandatory supply of information to error-prone individuals,[14] "soft" choice architecture,[15] and regulatory intervention to prevent and correct people's mistakes.[16] Areas that these reform proposals try to influence include accidents and risk regulation, consumer agreements, business contracts, credit and lending, employment, insurance, prenuptial agreements,

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endowment effect frustrates efficient bargaining even when transaction costs are zero, as parties overvalue their entitlements, which makes the initial allocation of legal entitlements consequential, contrary to the Coase Theorem).

10. Pp. 342–46. *See generally* Hal R. Arkes & Catherine Blumer, *The Psychology of Sunk Cost*, 35 ORGANIZATIONAL BEHAV. & HUM. DECISION PROCESSES 124, 126–36 (1985).

11. *See generally* DAN ARIELY, PREDICTABLY IRRATIONAL (2008) (unfolding a robust and radical account of people's irrational choices); RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS (2008) (describing people's irrationalities in probability and utility assessments and offering ways to fix them).

12. *See* Korobkin, *supra* note 2, at 1653–54 (attesting that behavioral economics has been broadly accepted in legal scholarship). *See generally* BEHAVIORAL LAW AND ECONOMICS (Jeffrey J. Rachlinski ed., 2009) (comprehensive area-based anthology); BEHAVIORAL LAW AND ECONOMICS (Cass R. Sunstein ed., 2000) (early area-based collection of articles).

13. For the seminal work that inaugurated the discipline and that became the most-cited law journal article since 1995, see Christine Jolls, Cass R. Sunstein & Richard Thaler, *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471 (1998). *See also* Korobkin, *supra* note 2, at 1654–55 (attesting that Jolls et al., *supra*, garnered the largest number of law journal citations since 1995).

14. *See, e.g.*, Oren Bar-Gill & Rebecca Stone, *Mobile Misperceptions*, 23 HARV. J.L. & TECH. 49 (2009) (using behavioral economics to propose expansive disclosure requirements in connection with cellular service agreements). *But see* Omri Ben-Shahar & Carl E. Schneider, *The Failure of Mandated Disclosure*, 159 U. PA. L. REV. 647 (2011) (criticizing the ongoing expansion of disclosure requirements).

15. *See* THALER & SUNSTEIN, *supra* note 11, at 81–100 (introducing the "choice architecture" method, understood as governmental manipulation of individuals' menu of choices in a manner that nudges those individuals to take the desired action).

16. For summary of regulatory initiatives driven by behavioral economics and an analytical framework for regulation premised on subjects' bounded rationality, see Michael P. Vandenbergh et al., *Regulation in the Behavioral Era*, 95 MINN. L. REV. 715, 763–78 (2011).

and adjudicative factfinding.[17] Kahneman's book outlines and approves of some of these proposed reforms (pp. 412–15).

Two features—theory and accessibility—make *Thinking, Fast and Slow* an indispensable book. Behavioral economics has existed for nearly four decades and is unlikely to fade away. Yet, prior to the publication of *Thinking*, behavioral economics had developed no integrated theory of bounded rationality's causes and characteristics.[18] Instead of developing such a theory, behavioral economists engaged in largely experimental work that uncovered discrete manifestations of people's bounded rationality. These manifestations include "representativeness,"[19] "availability,"[20] "anchoring,"[21] "overoptimism,"[22] "base-rate neglect,"[23] "hindsight bias,"[24] loss aversion (pp. 283–88), and other misevaluations of probability and utility (pp. 222–29, 363–74). Behavioral economists had developed no causal explanations for

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17. *See, e.g.*, Oren Bar-Gill & Elizabeth Warren, *Making Credit Safer*, 157 U. PA. L. REV. 1 (2008) (identifying and calling for regulatory correction of people's overoptimism in consumer credit agreements); Melvin Aron Eisenberg, *The Limits of Cognition and the Limits of Contract*, 47 STAN. L. REV. 211 (1995) (identifying overoptimism in people's liquidated damage undertakings, prenuptial agreements, and other areas of contract and commending a regime that authorizes courts to modify contractually prearranged payments and waivers); Jolls et al., *supra* note 13, at 1522–28 (identifying and calling for regulatory correction of hindsight biases in courts' determinations of negligence, environmental torts, punitive damages, and nonobviousness of patented inventions); Dan M. Kahan, *The Economics—Conventional, Behavioral, and Political—Of "Subsequent Remedial Measures" Evidence*, 110 COLUM. L. REV. 1616, 1623–25 (2010) (describing the effect of hindsight bias on factfinding in adjudication); Jeffrey J. Rachlinski, *A Positive Psychological Theory of Judging in Hindsight*, 65 U. CHI. L. REV. 571 (1998) (identifying presence of hindsight bias in courts' ascertainments of parties' compliance with ex ante norms and commending legal rules that counteract this bias); Cass R. Sunstein, *Legal Interference with Private Preferences*, 53 U. CHI. L. REV. 1129, 1167–68 (1986) (identifying and calling for regulatory correction of base-rate neglects in people's decisions about risk and insurance, contractual undertakings, and their own employment termination prospects); Sean Hannon Williams, *Sticky Expectations: Responses to Persistent Over-Optimism in Marriage, Employment Contracts, and Credit Card Use*, 84 NOTRE DAME L. REV. 733 (2009) (identifying and calling for regulatory correction of people's base-rate neglects and resulting overconfidence in marriage-related and employment agreements and in credit card borrowing); Eyal Zamir, *The Efficiency of Paternalism*, 84 VA. L. REV. 229, 269–70 (1998) (identifying and calling for regulatory correction of people's base-rate neglects and availability bias in savings and credit decisions).

18. For a similar line of critique, see Drew Fudenberg, *Advancing Beyond Advances in Behavioral Economics*, 44 J. ECON. LITERATURE 694, 696 (2006) ("[U]nless the insights and stylized facts obtained so far are related to a small number of models of individual behavior, with some guidelines for when each model should be expected to apply, behavioral economics may remain a distinct field with its own methodology.").

19. Chapter 14 (reliance on familiar stereotypes instead of base rates).

20. Chapter 12 (alignment of an event's probability to the ease with which it can be called to mind).

21. Chapter 11 (excessive reliance on the initial value of an event's probability).

22. Chapter 24 (also known as the "planning fallacy").

23. Chapter 16 (failure to account for general probabilities relevant to one's decision).

24. Chapter 19 (retrospective assessment of a probability that needs to be determined prospectively).

these misevaluations.[25] All they had done was identify, describe, and categorize these misevaluations one by one.

Thinking does not content itself with an untheorized catalog of descriptions; it goes considerably further, and seeks to develop a unified explanation of causes and effects. Remarkably, it is the first book to provide a comprehensive and theorized, as well as fully updated, account of bounded rationality. Kahneman's account of bounded rationality combines experimental and empirical findings with a causal theory. This theory builds on two reasoning mechanisms that, according to Kahneman and other psychologists, define people's mental makeup.[26] One of those mechanisms, identified as System 1, relies on intuition (pp. 19–30, 89–96, 105). Another mechanism, identified as System 2, relies on deliberation (pp. 19–30).

A person using System 1 thinks fast. Her thinking invokes instincts and hunches, of which some are experience based and others are biologically hardwired (pp. 24–25). These instincts and hunches enable her to form quick and effortless responses to tasks, questions, and challenges (p. 25). By and large, she bases her responses on familiar causal associations, while relying on the "What you see is all there is" assumption (pp. 85–88). This assumption conveniently establishes the person's informational base as a mix of her individual observations and experiences (p. 87). This mix is dependable for the most part, but it also results in wrong decisions being made in a nonnegligible number of cases (pp. 87–88). These wrong decisions result from an individual's failure to account for information that lies beyond her cognitive horizon (pp. 87–88). This cognitively remote and consequently unaccounted-for information includes statistical data that are often crucial for a person's decision (pp. 109–18).

System 2 relies on deliberation but still fails to protect people against probabilistic errors, as people use it selectively (pp. 39–49). Paradoxically, it is System 1 that decides whether a person will use System 2 (p. 44). As a result, people resort to System 2 only in a state of uncertainty and disbelief (p. 81)—that is, when they encounter a difficult task that calls for a disciplined analytical solution (e.g., finding the square root of 2,226,064). Since mental energy is a scarce resource, people use System 2 sparingly and slowly. As a result, System 2 becomes busy, lazy, and depleted (pp. 39–42), while System 1 dominates people's decisionmaking[27] and drives them into probabilistic misconceptions that substitute heuristics for data (pp. 109–84).

Thinking is beautifully written: its insights are rich, profound, and at the same time lucid and exceptionally well presented. These virtues make the

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25. *See* Fudenberg, *supra* note 18, at 696–98 (spotting weaknesses of causally unspecified accounts of bounded rationality).

26. *See* Keith E. Stanovich & Richard F. West, *Individual Differences in Reasoning: Implications for the Rationality Debate?*, 23 BEHAV. & BRAIN SCI. 645, 658–60 (2000) (introducing the concepts of System 1 and System 2).

27. *See* p. 41. Kahneman mentions that "[p]eople who are cognitively busy are also more likely to make selfish choices, use sexist language, and make superficial judgments in social situations." *Id.* (emphasis omitted). I find this hard to believe. Self-interest and social norms must calibrate System 1 to filter out socially inappropriate speech.

book accessible not only to a specialized readership, including economists, decision psychologists, and economically minded legal scholars, but also to readers possessing a basic familiarity with social science. As a grandmaster of psychology, Kahneman knows a lot about human intuition. In *Thinking*, he utilizes this knowledge to develop intuitive explanations for complex economic and psychological phenomena. Kahneman accompanies these explanations with brilliantly selected examples from real life and controlled experiments—a presentation that immensely benefits the book's reader. For nonspecialized readers, the book reproduces two famous articles in which Kahneman and Tversky developed the insights that defined behavioral economics as a field.[28]

The book's virtues, however, do not make it uncontroversial. In what follows, I examine Kahneman's account of people's probabilistic irrationality, an account that occupies the majority of the book.[29] This examination reveals my profound disagreement with Kahneman's grim assessment of ordinary people's reasoning, widely known as the "bounded rationality thesis."[30] Specifically, I posit that Kahneman and his collaborators use inadequate criteria for evaluating people's determinations of probability. These criteria fail to separate decisions that follow rules ("acceptances") from decisions that rely on rule-free intuitions ("beliefs"). These criteria also fail to recognize a distinct and perfectly rational mode of reasoning that associates an event's probability with the quantum and variety of evidence confirming the event's occurrence while eliminating rival scenarios (Baconian or causative probability). Moreover, Kahneman's methodology tolerates the presence of unspecified causality and malleable reference classes in experimental settings. These flaws are identified and analyzed in Parts I, II, and III below. I show that these flaws foil Kahneman's experiments, which mix statistical data with case-specific information. As a result, these experiments do not reveal anything about the rationality of people's probabilistic decisions. Indeed, I demonstrate that those decisions are entirely rational.

I. Revisiting Bounded Rationality

My critique of Kahneman's bounded rationality thesis rests on two independent grounds: methodological and probabilistic. I find Kahneman's account methodologically deficient because it ignores the division between

28. Pp. 419–48. The reproduced articles are Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 Science 1124 (1974), and Daniel Kahneman & Amos Tversky, *Choices, Values and Frames*, 39 Am. Psychologist 341 (1984).

29. This account occupies Parts II and III of the book, titled respectively "Heuristics and Biases" and "Overconfidence." The discussion in Part I ("Two Systems") and Part V ("Two Selves") identifies the causes of people's misevaluations of probability and utility. Only Part IV ("Choices") focuses exclusively on the formation of people's utility preferences.

30. *See* Kahneman, *supra* note 3.

"belief" and "acceptance" drawn by philosophers of rationality.[31] Under this taxonomy, "acceptance" is a mentally active process that includes application of decisional rules to available information.[32] "Belief," by contrast, is a person's feeling, sensation, or hunch: an intellectually passive state of mind generated by unanalyzed experiences.[33]

Importantly, "belief" and "acceptance" are not analogs of System 1 and System 2. The System 1–System 2 taxonomy captures the intensity of a person's brainwork. To this end, it focuses on whether the person puts deliberative effort into her decisions (System 2) or decides quickly and unreflectively by using her intuition (System 1). By contrast, the belief–acceptance taxonomy captures the brainwork's normative content by separating the person's rule-free decisions (beliefs) from her rule-driven decisions (acceptances). System 1 and System 2 can generate both beliefs and acceptances, depending on whether the person follows decisional rules intuitively or reflectively. To be sure, a rule follower will use System 2 more often than System 1. Many people, however, also develop rule-driven instincts: drivers following the "two-second rule" to avoid colliding with a vehicle ahead of them are a good example of persons making rule-driven decisions that fall under System 1. On the other hand, some people may expend their deliberative efforts (System 2) on the formation of rule-free beliefs.

Behavioral experiments underlying the bounded rationality thesis uniformly miss the belief–acceptance distinction. People who participate in these experiments develop no rule-based acceptances, nor are they asked to form such acceptances by the experimenters. All they do is report their preanalytical beliefs because that is what the experimenters ask them to do. People's rationality, however, can only be evaluated by reference to their acceptances that apply rules of reasoning.[34] Identifying the criteria, or rules, that people apply in their evaluations of probability is therefore of far greater consequence than whether they think fast or slow.

David Hume's magnum opus, *A Treatise on Human Nature*, long ago anticipated the belief–acceptance divide in people's ascriptions of probabilities to uncertain events.[35] Hume distinguished between "philosophical" probability or normative belief—which attaches to "chances"[36] and "causes"[37]—and

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31. *See* L. Jonathan Cohen, An Essay on Belief and Acceptance 1–27, 100–08 (1992) (delineating the differences between "belief" and "acceptance").

32. *Id.* at 16–20.

33. *Id.*

34. *Id.* at 88 ("Nor would [a belief] deserve praise or blame in the way that a responsible act of acceptance deserves it.").

35. *See* 1 David Hume, A Treatise of Human Nature 97–104 (David Fate Norton & Mary J. Norton eds., Oxford Univ. Press 2007) (1739) (distinguishing between intuitive ("unphilosophical") and rule-based ("philosophical") probabilities).

36. *Id.* at 86–89.

37. *Id.* at 89–97.

"unphilosophical" probability or unreflective belief.[38] Hume's account of "unphilosophical" probability presciently identified the psychological phenomena now known as "availability,"[39] "representativeness,"[40] "base-rate neglect,"[41] and "hindsight bias."[42] Importantly, Hume did not suggest that people are predestined to use "unphilosophical" probability instead of normative probability. Rather, he argued that "unphilosophical" probabilities are hard (albeit not impossible) to control.[43]

Behavioral economists' disregard of Hume's work is unfortunate. Even more disappointing is Kahneman's and other behavioral economists' failure to investigate people's acceptances as distinguished from their beliefs. As I explain below in Part II, this omission undermines the bounded rationality thesis in the area of probability. Failure to separate rule-based acceptances from rule-free beliefs has also led Kahneman and other behavioral economists to conflate people's cognitive *performance* with cognitive

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38. *Id.* at 97–104.

39. Below is Hume's description of the "availability" heuristic:

> An experiment, that is recent and fresh in the memory, affects us more than one that is in some measure obliterated; and has a superior influence on the judgment, as well as on the passions. A lively impression produces more assurance than a faint one; because it has more original force to communicate to the related idea, which thereby acquires a greater force and vivacity.

Id. at 98.

40. *Id.* ("A greater force and vivacity in the impression naturally conveys a greater [sic] to the related idea; and 'tis on the degrees of force and vivacity, that the belief depends, according to the foregoing system.").

41. Hume's criticism of base-rate neglect appears in his famous essay on miracles. *See* David Hume, Enquiries Concerning Human Understanding and Concerning the Principles of Morals 109–31 (P.H. Nidditch ed., 3d ed., Oxford Univ. Press 1975) (1777). For superb analysis of Hume's essay, see David Owen, *Hume Versus Price on Miracles and Prior Probabilities: Testimony and the Bayesian Calculation*, 37 Phil. Q. 187, 188–91 (1987) (explaining Hume's critique of people's natural inclination to believe credible witnesses who report on improbable events).

42. *See* 1 Hume, *supra* note 35, at 100 ("In almost all kinds of causes there is a complication of circumstances, of which some are essential, and others superfluous; some are absolutely requisite to the production of the effect, and others are only conjoined by accident. Now we may observe, that when these superfluous circumstances are numerous, and remarkable, and frequently conjoined with the essential, they have such an influence on the imagination, that even in the absence of the latter they carry us on to the conception of the usual effect, and give to that conception a force and vivacity.").

43. Remarkably, Hume also identified the "endowment effect" in people's valuations of their possessions:

> Such is the effect of custom, that it not only reconciles us to any thing we have long enjoyed, but even gives us an affection for it, and makes us prefer it to other objects, which may be more valuable, but are less known to us. What has long lain under our eye, and has often been employed to our advantage, *that* we are always the most unwilling to part with; but can easily live without possessions, which we never have enjoyed, and are not accustomed to.

Id. at 323.

competence.[44] This conflation makes the resulting behavioral accounts deficient. The fact that a person systematically makes statistical errors in forming her beliefs does not establish that she would also commit those errors in forming her acceptances—a process in which she would familiarize herself with and reflectively apply the requisite statistical rules. In fact, empirical studies of statistical education report the considerable success of the various learning methods through which students acquire understandings of statistical inference.[45]

My probabilistic critique of Kahneman's theory unfolds in Part III. This critique questions the statistical–causative mix of information on which Kahneman, Tversky, and other behavioral economists base their experiments. To see what I mean by the "statistical–causative mix," consider one of Kahneman and Tversky's most famous experiments, widely known as the "Blue Cab Problem."[46] Kahneman, Tversky, and their collaborators told their participants about a hit-and-run accident that occurred at night in a city in which 85% of cabs were blue and 15% were green. They also told the participants that the hit-and-run victim filed a lawsuit against the companies operating those cabs—identified respectively as "Blue Cab" and "Green Cab"—and that an eyewitness testified in the ensuing trial that the cab that hit the victim was green. Another piece of information that the participants received concerned a rather unusual procedure that took place at this trial. The experimenters told the participants that "[t]he court tested the witness' ability to distinguish between Blue and Green cabs under nighttime visibility conditions [and] found that the witness was able to identify each color correctly about 80% of the time, but confused it with the other color about 20% of the time."[47] Based on this information, most participants in the experiment assessed the probability that a green cab hit the victim at 0.8, presumably because they believed that this was the probability that the eyewitness's testimony was correct (p. 167).

This probability assessment aligned with the given credibility of the witness, but not with Bayes' Theorem.[48] The prior odds that the errant cab was green as opposed to blue, $P(G)/P(B)$, equaled 0.15/0.85. To calculate the posterior odds, $P(G|W)/P(B|W)$, with W denoting the witness's

44. This conflation was first spotted by L. Jonathan Cohen, *Can Human Irrationality Be Experimentally Demonstrated?*, 4 BEHAV. & BRAIN SCI. 317, 328–29 (1981).

45. *See, e.g.*, Pip Arnold et al., *Enhancing Students' Inferential Reasoning: From Hands-On to "Movies"*, J. STAT. EDUC., July 2011, *available at* http://www.amstat.org/publications/jse/v19n2/pfannkuch.pdf (reporting success in teaching statistical inference to fourteen-year-old students with the help of hands-on physical simulations); Simin Hall & Eric A. Vance, *Improving Self-Efficacy in Statistics: Role of Self-Explanation & Feedback*, J. STAT. EDUC., Nov. 2010, *available at* www.amstat.org/publications/jse/v18n3/hall.pdf (reporting success in teaching introductory statistics with the help of students' self-explanation and peer feedback).

46. Pp. 166–70; *see also* Maya Bar-Hillel, *The Base-Rate Fallacy in Probability Judgments*, 44 ACTA PSYCHOLOGICA 211, 211–12 (1980).

47. Bar-Hillel, *supra* note 46, at 211–12.

48. For exposition and proof of Bayes' Theorem, see Stein, *supra* note 5, at 211–13.

testimony, these odds had to be multiplied by the likelihood ratio. This ratio equalled the odds attaching to the scenario in which the witness identified the cab's color correctly, rather than incorrectly: $P(W|G)/P(W|B)$. The posterior odds consequently equaled $(0.15 \cdot 0.8)/(0.85 \cdot 0.2)$—that is, 12/17. The probability that the victim's allegation against Green Cab was true thus amounted to $12/(17 + 12)$ or 0.41—far below the "preponderance of the evidence" standard (> 0.5) that applies in civil litigation. The experiment thus seems to provide an elegant and robust demonstration of individuals' total neglect of base rates.

This and similar experimental vignettes have a serious flaw that I call unspecified causality. The experimenters did not tell the participants that the relative frequency of blue and green cabs' appearances on the streets of the city could somehow affect the witness's capacity to tell blue from green. This causal effect is quite unusual: an ordinary person can tell blue from green even when she sees one green cab and many blue cabs.[49] The experimenters therefore ought to have told the participants that the witness's ability to distinguish between blue and green cabs might have been affected by the frequency with which those cabs appeared on the streets. Alternatively, the experimenters ought to have told the participants that in cases in which the witness failed to give the correct identification of the cab's color, she made this mistake randomly rather than for some specific reason.[50]

The experimenters, in other words, ought to have ruled the causality factor in or out. Instead, they allowed the participants to deal with the unspecified causality as they deemed fit, and the participants rendered an unsurprising—albeit not watertight—verdict that the distribution of cabs' colors in the city did not affect the witness's ability to tell blue from green. Absent a causal connection between these two factors, the errant cab's probability of being green as opposed to blue was indeed 0.8.

Unspecified causality is also a serious flaw because it makes the relevant reference class malleable.[51] To see how this malleability affected the Blue Cab Problem, factor in the preponderance requirement that a plaintiff in a civil suit needs to satisfy in order to win the case.[52] Under this requirement, the victim was certainly entitled to win her suit against Green Cab when the errant cab's probability of being green, given the testimony of the witness—$P(G|W)$—was greater than 0.5. The victim, however, was equally entitled to win the suit when the probability of the scenario in which the witness correctly identified a green cab—$P(W|G)$—was greater than 0.5. The relevant

49. *See* Cohen, *supra* note 44, at 329 ("[I]f the green cab company suddenly increased the size of its fleet relative to that of the blue company, the accuracy of the witness's vision would not be affected, and the credibility of his testimony would therefore remain precisely the same in any particular case of the relevant kind.").

50. *See* Stein, *supra* note 5, at 253–55.

51. For an outstanding analysis of reference-class malleability, see Ronald J. Allen & Michael S. Pardo, *The Problematic Value of Mathematical Models of Evidence*, 36 J. Legal Stud. 107, 111–14 (2007).

52. *See* Alex Stein, Foundations of Evidence Law 143–48, 219–25 (2005) (explaining the preponderance requirement and its underlying justifications).

reference class, in other words, could have been either the cab's color or the witness's accuracy.[53] The participants therefore could not be wrong in selecting the witness's accuracy as the relevant reference class. This perfectly rational choice allowed the participants to treat the probability of the witness's accuracy (0.8) as a dominant factor in their decision.

More fundamentally, the mix of statistical and causative information brings into consideration the normative openness of the "probability" concept.[54] As a normative matter, the Blue Cab Problem can be analyzed under two distinct analytical frameworks: mathematical (Pascalian) and causative (Baconian).[55] The mathematical framework uses Bayes' Theorem, application of which gives the victim's suit against Green Cab a 0.41 probability (if we ignore the unspecified causality and the reference-class problem). This probability represents the errant cab's chances of being green rather than blue, with a cab-identifying witness scoring 80 out of 100 on similar identifications in a city in which 85 percent of the cabs are blue and 15 percent are green.

The causative framework, on the other hand, yields an altogether different result, close to the mathematical probability of the witness's accuracy (0.8). Under this framework, an event's probability corresponds to the quantum and variety of the evidence that confirms the event's occurrence while eliminating rival scenarios.[56] This qualitative, evidential criterion separates causative probability from the mathematical calculus of chances.[57] Under this criterion, the witness's testimony that the errant cab was green was credible enough to rule out the "errant blue cab" scenario as causatively implausible. On the other hand, the distribution of blue and green cabs in the city had no proven effect on the witness's capacity to tell blue from green. The witness's testimony consequently overrode the cabs' distribution evidence and removed it from the factfinding process. This eliminative method (favored by Francis Bacon and John Stuart Mill[58]) allowed the participants to evaluate the probability of the victim's case at 0.8. This factfinding method is not devoid of difficulties, but it is also far from being irrational.[59]

Contrary to Kahneman's view, the Blue Cab Problem and similar experiments do not establish that people's probability judgments are irrational.[60] These judgments *are* predominantly rational and consequently do not call

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53. This insight belongs to Owen, *supra* note 41, at 199.

54. *See* Stein, *supra* note 5, at 200–04.

55. *Id.* at 253–56.

56. *Id.* at 243–46.

57. *Id.* at 235–46.

58. *Id.* at 204–06, 236–40.

59. *See id.* at 236–40.

60. *Cf.* Gerd Gigerenzer, *On Narrow Norms and Vague Heuristics: A Reply to Kahneman and Tversky (1996)*, 103 PSYCHOL. REV. 592, 593 (1996) (criticizing Kahneman and Tversky for testing people's ascriptions of probabilities to single events not amenable to such assessments).

for the government's paternalistic intervention.[61] The legal system need not do more than remedy people's informational shortfalls—not their cognitive incapacities—by applying the conventional doctrines of foreseeability, disclosure, informed consent, unconscionability, and consumer protection.

II. Belief Versus Acceptance

Kahneman's failure to separate beliefs from acceptances looms large in the "Linda Problem"—another celebrated experiment that he and Tversky carried out (p. 156). Linda was described to participants as a thirty-five-year-old woman, who was "single," "outspoken," "very bright," and deeply concerned with "issues of discrimination and social justice." Linda's college life included majoring in philosophy and participating in antinuclear demonstrations. Participants were asked to select Linda's occupation and social identity from the list provided by Kahneman and Tversky (pp. 156–57). "Bank teller" and "feminist bank teller" were among the options on that list. Most participants ranked Linda's being a "feminist bank teller" as more probable than Linda's simply being a "bank teller" (p. 158).

This assessment of probability defies mathematical logic. Linda's feminism was a probable, but still uncertain, fact. Her occupation as a bank teller was a merely probable, rather than certain, fact as well. The probability of each of those characteristics was somewhere between 0 and 1. Hence, the probability that these two characteristics would be present simultaneously was necessarily lower than the probability that attached to each individual characteristic. Linda was more likely to have only the "bank teller," or only the "feminist," characteristic than to possess both characteristics at once (p. 158). Assuming that the characteristics are mutually independent and that the probability of each characteristic is, say, 0.6, Linda's probability of being a feminist bank teller would equal 0.36. Remarkably, this experiment's results were replicated with doctorate students at Stanford Business School (p. 158).

To verify this important finding, Kahneman and Tversky conducted another experiment that featured a simple question: "Which alternative is more probable? Linda is a bank teller. Linda is a bank teller and is active in the feminist movement" (p. 158). Once again, the participants ranked the second joint-event scenario as more probable than the first single-event scenario (p. 158).

Kahneman reports that after completing one such experiment, he asked the participants, "Do you realize that you have violated an elementary logical rule?" In response, a graduate student said, "I thought you just asked for my opinion" (p. 158). Kahneman cites this response to illustrate the stickiness of people's probabilistic irrationality: the student who gave this

61. Note that not all behavioral economists favor paternalism. *See, e.g.*, Korobkin, *supra* note 2, at 1659 (calling for "refocusing the general policy discussion in law and economics scholarship away from a pro- or antiregulatory dogmatism toward comparative institutional analysis, in which the unregulated market must compete with administrative, legislative, and judicial activism for claims to normative superiority in different contexts").

response believed that her *opinion* on factual matters could defy mathematical logic.

The student's response, however, ought to have moved Kahneman in a different direction. What the student was actually saying was "Had I known that you were expecting me to give you not just my best hunch about Linda's job and social identity, but rather a rule-based evaluation of the relevant probabilities, my answer might have been different." The student, in other words, understood the experiment as asking her to express her belief, rather than articulate and apply her criteria for acceptances. In forming this belief, she felt free to rely on her common sense and experience rather than on statistical rules. Her reasoning aligned with that of scientists who begin their inquiries with intuitive beliefs that they subsequently accept or reject.[62]

Similarly to Kahneman's other experiments, the Linda Problem could only elicit the beliefs that participants intuitively formed. Those beliefs do not tell us much about the participants' probabilistic rationality. Forming a rule-free belief, as opposed to a rule-driven acceptance, does not commit the believer to any specific reason, or rule, that she will follow in her other decisions.[63] Acceptances driven by rules of reasoning are different. Most medical patients, for example, would attest that having a spine surgery followed by a coronary bypass operation is riskier than undergoing a spine surgery alone. This attestation correctly applies the product rule for conjunctive probabilities to facts that the patient deeply cares about. Unsurprisingly, it expresses the patient's acceptance rather than belief.

As far as beliefs are concerned, the participants' prevalent reaction to the Linda Problem was far from irrational. Formation of a person's belief always calls in the experience that a person has accumulated throughout her life.[64] This experience cannot be artificially blocked by statistical rules, unless the person is expressly told to suppress all of her beliefs that do not conform to those rules and to base her decision on acceptance.[65] From the standpoint of an ordinary person's belief, the single-event scenario "Linda is a bank teller" was incomplete because the work of bank tellers does not normally occupy their entire lives. The absence of information about Linda's social identity and afterwork engagements thus created a gap fillable by experience. Hence, it was entirely rational for participants to make an experience-based assumption that Linda must have *some* social identity or afterwork engagement. This assumption made the participants focus on the following question: Is it more probable that "Linda is a feminist bank teller"

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62. *See* COHEN, *supra* note 31, at 89–90.

63. *Cf.* Frederick Schauer, *Giving Reasons*, 47 STAN. L. REV. 633 (1995) (associating decisionmakers' reasons with their implicit commitment to apply similar reasons in future cases).

64. *See, e.g.*, 1 HUME, *supra* note 35, at 102 (famously explaining "belief" as a consequence of the believer's "number of past impressions and conjunctions").

65. *Cf.* L. Jonathan Cohen, *Should a Jury Say What It Believes or What It Accepts?*, 13 CARDOZO L. REV. 465 (1991) (arguing that jurors should suppress their beliefs and determine facts through "acceptance").

or that "Linda is a bank teller whose social identity and afterwork engagements are feminism free"?[66]

Based on Linda's background information, the participants were absolutely (and unsurprisingly) correct in forming a belief that ranked Linda's feminism above other afterwork engagements. In technical terms, Linda's probability of being a bank teller and a feminist, $P(T\&F)$, equaled $P(T) \cdot P(F)$. Correspondingly, Linda's probability of being a bank teller while having a nonfeminist afterwork engagement, $P(T\&NF)$, equaled $P(T) \cdot P(NF)$. Under the factual setup that the participants were asked to consider, Linda was more likely to be a feminist than a nonfeminist: $P(F) > P(NF)$. Hence, $P(T\&F) > P(T\&NF)$.

To preclude the formation of this rational belief, Kahneman and his associates ought to have asked the participants a simple question, suggested by Gerd Gigerenzer: "There are 100 persons who fit the description above (that is, Linda's). How many of them are: Bank tellers? Bank tellers and active in the feminist movement?"[67] This question would have predominantly elicited the statistically correct response.[68]

Kahneman's anticipated reply to this critique might fall along the following lines: The participants' real task was to cut through the "noise" (the statistically meaningless information) and see what the experimenters asked them to do. The participants, so goes the argument, ought to have noticed that their task was to compare the probabilities of a single event and a compound, or conjunctive, event. Had the participants noticed that, they also would have noticed that Linda's probability of being a feminist bank teller was conceptually no different from the proverbial coin's probability to reveal *heads* in two successive throws. On a 0 to 1 scale, this probability equals $0.5 \cdot 0.5 = 0.25$.

The coin analogy, however, is untidy because Linda's social identity and afterwork engagement were not an unrigged coin. Linda's background information made her engagement in feminist causes the most probable afterwork scenario. Arguably, this scenario was more probable than the scenario in which Linda's work as a bank teller—surprisingly fulfilling or unduly exhaustive—represented everything she did in her life.

The upshot of my preceding discussion is straightforward. Studies of people's probabilistic decisions are not very fruitful when they focus on intuitive beliefs. Focusing on people's rule-driven acceptances in settings that call for statistical reasoning—as in my double-surgery example—could give Kahneman and his collaborators a much better sense of people's probabilistic rationality.

Kahneman and his collaborators have chosen not to go along this route. Instead of adopting a simple all-statistics setup for their experiments, they

66. *Cf.* Gerd Gigerenzer, *I Think, Therefore I Err*, 72 Soc. Res. 1, 8–9 (2005) (criticizing the Linda Problem and similar experiments for their reliance on a "content-blind" norm for rationality).

67. *Id.* at 10.

68. *Id.*

mix statistical data with case-specific information. This informational mix can be found not only in the Linda Problem. Almost every experiment associated with the Kahneman and Tversky school of thought uses this mix, and there is a reason for that as well. Kahneman explains that causal associations corrupt people's decisions: people try to find causal connections where none exists, while irrationally discounting important statistical information (pp. 74–78). This cognitive malfunction has shaped Kahneman's and his associates' experimental agendas. Kahneman and his associates seek to uncover how people's "causation illusion" drives them to ignore statistical data and depart from statistical reasoning.

My examination of Kahneman's "causation illusion" theory will take place in Part III. In the remainder of this Part, I revisit a methodological concern that has appeared in prior literature but failed to draw Kahneman's attention.[69] Kahneman and his collaborators' experimental method implicates "entrapment by noise." The experimenters pit statistical data against case-specific information, perceived as uninformative "noise." The "noise" is introduced to divert the unwary participants from the solid statistical data. In the Blue Cab Problem, the postulated veracity of a case-specific testimony coming from an eyewitness served as a trap. The Linda Problem featured a similar trap: the young woman's attraction to feminism. The experimenters then asked the participants to deal with a case-specific question ("How likely is it that the victim was hit by a green cab?" and "Is Linda more likely to be a bank teller than a feminist bank teller?").

These traps show nothing besides the conjurer's sleight of hand: each trap can only work once against the same person.[70] After falling into one of these traps, the unsuspecting person only needs to be told that, under the given rules, she was not supposed to have allowed "soft" case-specific information to override "hard" statistical data. After adopting this normative premise as her rule for future decisions, the person will no longer make the same mistake.[71] If she knows the applicable statistical rules, she will apply them correctly. If she is unfamiliar with those rules, she will try to find out what they are and, if necessary, seek expert advice.[72] Under neither scenario can such a person be considered cognitively incompetent and in need of the government's intervention.

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69. *See* Cohen, *supra* note 44, at 328–29.

70. *See* Alex Stein, *A Liberal Challenge to Behavioral Economics: The Case of Probability*, 2 N.Y.U. J.L. & LIBERTY 531, 537–38 (2007) (making the "sleight of hand" point).

71. *See* ARTHUR S. REBER, IMPLICIT LEARNING AND TACIT KNOWLEDGE 35–45 (1993) (reporting experimental studies that showed success in people's internalization of probabilistic rules).

72. Kahneman also questions experts' ability to avoid fallacies in probabilistic reasoning. *See* Chapters 21–22. His evidence, however, is not robust enough to support this skepticism.

III. Causation Versus Chance

Kahneman criticizes people for putting too much faith in causation (pp. 74–78, 114–18, Chapter Sixteen), yet he himself canonizes chance. Kahneman assumes that incomplete causal indicators can only create an associative illusion of causation (pp. 74–78). At the same time, he professes that incomplete statistical indicators—the chances that surround us—are real and hence dependable (Chapters Six, Sixteen).

This unexplained normative asymmetry is best illustrated by another milestone experiment of Kahneman and Tversky. Aimed at identifying the "representativeness" bias, the "Steve Problem" featured Steve, described to participants as "very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail" (p. 420). The experimenters asked the participants to choose Steve's most probable occupation from a list that included "farmer, salesman, airline pilot, librarian, [and] physician" (p. 420). According to Kahneman and Tversky, the participants used familiar (i.e., "representative") stereotypes to identify Steve as a likely librarian, while ignoring the fact that librarians are vastly outnumbered by farmers (p. 420).

Kahneman assumes that there was only one correct way to answer the question about Steve's job (pp. 420–21). According to Kahneman, the participants had to find out the percentage of farmers, salesmen, airline pilots, librarians, and physicians in the general pool of working males. This percentage determined Steve's probability of being a farmer, a salesman, an airline pilot, a librarian, or a physician. Kahneman believes that trying to identify Steve's profession through his personality traits was doomed to fail, as these traits were rather weak causal indicators of a person's professional identity. The general statistic representing an average working male's chances of having one of the above-mentioned professions was a far more dependable indicator. This indicator therefore ought to have trumped the uninformative individual traits. The participants' failure to notice this statistical indicator, and their consequent reliance on Steve's individual traits, was a cognitive error (pp. 420–21).

I posit that this experiment was poorly designed. Steve's personality traits did not make him a librarian, but they were certainly relevant to his choice of profession. If so, the participants should have been looking for a different, and more refined, statistic. Specifically, they should have been looking for the percentage of farmers, salesmen, airline pilots, librarians, and physicians in the general pool of working males who are shy, withdrawn and helpful, have meek and tidy souls and a passion for detail, and also need order and structure, while exhibiting little interest in people and the world of reality. Of course, this investigation would have been futile because general employment statistics do not single out the subcategory of working males formulated by Kahneman and Tversky. However, the fact that this investigation would have been futile does not make it inconsequential. Information revealing Steve's job preferences was material. Distribution of professions across working males generally was a rough and potentially misleading substitute for that information. This distribution was informative, but its evidential value did not outweigh the evidential value of Steve's personality traits. Kahneman apparently thinks that it did, but this is just an opinion rather than empirical fact. People participating in the experiment were entitled to use their opinions instead.

The Steve Problem's design incorporated unspecified causality. This feature opened two decisional routes for the experiment's participants. One could rationally estimate Steve's probability of being a librarian as a matter of chance. Alternatively, one could estimate this probability as a question of Steve's choice. Under the framework of chance, decisionmakers would rely on the distribution of relevant professions across working males in general. Under the framework of choice, they would consider a probable bargaining equilibrium between Steve and prospective employers. This equilibrium solution would practically remove from the list the physician, the pilot, and the salesman. Arguably, as between being a farmer and being a librarian, Steve would choose to be a librarian. Finding a librarian position might be difficult—given the scarcity of such positions, relative to the many jobs available on a farm—but Steve could succeed in getting it.

Kahneman disapproves of the participants' preference for the choice framework. Notwithstanding his disapproval, this preference is perfectly rational. The choice framework is not problem free, given the scarcity of case-specific information about Steve, but extrapolating Steve's probable occupation from the general pool of working males is equally problematic. Both modes of reasoning rely heavily on speculation, and there is consequently no way to tell which of them is epistemically preferable. Calling one of these modes of reasoning "rational" and another "irrational" is simply wrong.

Unspecified causality in an experiment's design *always* makes the relevant reference class malleable. Consider again Steve's case. Individuals participating in this experiment could have perceived their task in two completely different ways. They could have asked themselves whether Steve's personality traits separate him from the average working male. According to Kahneman, this was the right question to ask. However, an alternative—and equally rational—way to define the reference class was to focus on a narrower category of working males who have Steve's characteristics. The relevant reference class, in other words, could be either of the following: (1) males, as distributed across different professions; or (2) professions, as distributed across different males. The first of these categories emphasizes chance, while the second centers on choice. There is no way to determine which of those categories is more dependable than the other as a basis for statistical inference. Kahneman evidently prefers chance over choice. The participants in his and Tversky's experiments chose the opposite. As for myself, I remain undecided.

Kahneman's preference for chance over choice gets extreme in his discussion of capitalism and entrepreneurship (pp. 256–63). This section of Kahneman's book identifies the widespread presence of entrepreneurial luck. According to Kahneman, a risky business venture that beats the odds—for example, opening a successful restaurant in an economic environment in which most new restaurants fail and close soon after opening (pp. 256–57)—must not be easily credited to the entrepreneur's shrewdness. More often than not, good fortune is the real cause of the venture's success. From an ex ante perspective, the entrepreneur's venture originated from a serious probabilistic error: a decision to invest in a venture that disregarded the venture's low probability of success. The venture consequently was destined to fail. Ex post, however, the entrepreneur came upon luck and succeeded against the odds. Her profit from the venture is consequently a windfall or, at best, the fortuitous outcome of a wild gamble.

This characterization of entrepreneurial profits has an important normative implication that rejects the classic economic view.[73] From both a moral and economic point of view, a society that sets up welfare and social safety nets to protect citizens against the consequences of misfortune and disaster has a strong case for obligating a person who comes upon luck to share her windfall with others. According to this view, society can justifiably capture a substantial fraction of entrepreneurial windfalls by imposing high taxes on unearned profits.[74]

Unfortunately, Kahneman's account of entrepreneurship is flawed in several respects. For one thing, successful entrepreneurs often try to promote a number of independent ventures simultaneously. Consider an entrepreneur who promotes three mutually independent ventures, and assume that each venture has a 0.3 probability of success. Because the entrepreneur has diversified her business, her probability of succeeding in one of those ventures equals 0.66.[75] This probability increases the entrepreneur's expected profit to a level that might well justify her investment in the ventures. More importantly, the entrepreneur may have case-specific knowledge not available to her competitors on the market. This knowledge makes Kahneman's statistical averages altogether irrelevant.[76]

Kahneman criticizes people's reliance on case-specific knowledge as a "law of small numbers" (Chapter Ten). This criticism is far removed from

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73. *Cf.* Frank H. Knight, Risk, Uncertainty and Profit 284–85 (1921) (famously arguing that entrepreneurs move an economy forward by taking risks and hence should be allowed to capture the gains of their ventures).

74. *See* Eric Kades, *Windfalls*, 108 Yale L.J. 1489, 1494–96 (1999) (justifying society's capture of private windfalls on efficiency grounds because a "taxation of rents does not alter agents' economic decisions").

75. The simplest way to calculate this probability is to subtract the compound probability of the ventures' failure ($0.7^3 = 0.34$) from 1. This calculation derives from the classic portfolio theory. *See* Harry M. Markowitz, Portfolio Selection 37–71 (1959).

76. *Cf.* Henry E. Smith, *Property and Property Rules*, 79 N.Y.U. L. Rev. 1719, 1722–31, 1755–56 (2004) (preferring a decentralized regime that allows owners to increase wealth through heterogeneous utilizations of property to a system that overrides owners' holdouts by authorizing efficient takings of their property in exchange for a court-determined average price).

how most people—including judges and juries[77]—ascertain facts in their day-to-day lives. Kahneman's skepticism about case-specific knowledge also cannot be justified as a wholesale proposition, for it brushes aside a distinct mode of probabilistic reasoning, known as causative or Baconian probability.[78] Kahneman's disregard of Baconian probability is perplexing. This mode of probabilistic reasoning is perfectly rational,[79] and it also could explain—and, indeed, justify—people's decisions that Kahneman and his collaborators describe as erroneous.[80]

Under the Baconian system, a combination of credible case-specific evidence and experience can develop a single causal explanation for the relevant event that will override the competing statistical explanations.[81] This override is the essence of the Baconian elimination method.[82] For example, in the Blue Cab Problem, participants were entitled to assign overriding force to the witness's testimony that the errant cab was green. This testimony was not watertight, but it was credible and event specific. The event's causal impact on the witness's perceptive apparatus qualitatively differed from the city's cab-color statistics. This impact might have been epistemically superior to those statistics and therefore properly overrode them in the participants' minds.

This override was likely at work in the Steve Problem as well. There, participants used Steve's personality traits to eliminate from their list every profession that did not fit the stereotype associated with these traits. "Librarian" was the only item that survived this elimination procedure, which led the participants to estimate that Steve must be a librarian. Kahneman correctly observes that this estimate was unfounded (p. 420).[83] He is, however, too quick to denounce the participants' reasoning for failing to account for a random male's probability of being a farmer, as opposed to a librarian. Under the Baconian system of probability, the elimination method that the participants chose to use was valid. The participants may have misapplied this method, as they did not have enough evidence for choosing the librarian over the farmer, but they were perfectly rational in deciding to use it.

77. *See* STEIN, *supra* note 52, at 80–106 (explaining case-specificity requirements in the law of evidence).

78. *See* Stein, *supra* note 5, at 204–06, 235–46.

79. *See id.*

80. *See* L. JONATHAN COHEN, THE DIALOGUE OF REASON: AN ANALYSIS OF ANALYTICAL PHILOSOPHY 165–68 (1986) (explaining why it is rational for people to rely on causative probabilities instead of naked statistics).

81. Stein, *supra* note 5, at 235–46.

82. *Id.* at 204–06.

83. P. 420 ("In the case of Steve . . . the fact that there are many more farmers than librarians in the population should enter into any reasonable estimate of the probability that Steve is a librarian rather than a farmer.").

Conclusion

The accomplishments of the Behavioral Economics movement, led by Kahneman and Tversky, are numerous and impressive. The most significant of those accomplishments is the reorientation of economics from a predominantly theoretical modeling of rational choice to empirical and experimental studies that focus on people's real-life decisions. Scholars and policymakers interested in understanding this reorientation must read *Thinking, Fast and Slow*. This book is the best in the field and will retain this status for years to come. A more specific, yet equally remarkable, achievement of the movement, for which full credit goes to Kahneman and Tversky, is the "prospect theory" that powerfully explains people's valuations of uncertain gains and losses (Chapters Twenty-Five to Twenty-Seven).

Unfortunately, I cannot say the same about Kahneman and his collaborators' contribution to the understanding of people's assessments of probability. As I demonstrated in this Review, Kahneman and his collaborators attempt to advance this understanding by using an incomplete and unstable set of criteria for rational determinations of probability. This set is incomplete in that it does not separate intuitive "beliefs" from rule-based "acceptances" and gives no recognition to Baconian probability. This set is unstable because it tolerates unspecified causality and malleable reference classes. Evaluating the rationality of people's probabilistic decisions by applying this set of criteria is consequently wrong. A person who fails to align her intuitive beliefs with the rules of probability may well be rational in her rule-based decisions. A person who relies on Baconian probability in making case-specific decisions is not irrational either. And a person who ascribes probability to a causally unspecified event featuring a malleable reference class can simply never go wrong: her guesswork will be as good as anyone else's.

The incompleteness and instability of Kahneman's normative framework have an additional troubling implication for behavioral economics. This framework allows behavioral economists to portray as irrational *any decision* that a person might make in a given situation. Consider the following hypothetical scenario: To increase faculty members' productivity, Jane's university offers her a substantial raise in exchange for giving up her tenure as an economics professor. Jane is a prolific scholar, a gifted teacher, and a valuable institutional player who is much admired by her colleagues. Her probability of being fired is therefore extremely low. Jane nevertheless turns the university's offer down. As any behavioral economist would attest, this decision suffers from the "endowment effect"—an overvaluation of Jane's tenure that kills an economically beneficial transaction. Assume now that Jane changes her mind and accepts the university's offer. This decision could also be deemed irrational because it fails to reflect the fact that Jane cannot accurately predict her untold future as an academic. Many behavioral economists would be ready to attest that Jane's acceptance of the university's offer exhibits overoptimism—the "planning fallacy" in Kahneman's terms.[84]

Is there a way out of this maze?[85] As this Review is getting too long, I leave this question for readers to decide. For my part, I can only recommend that Jane decline Kahneman's invitation to think of herself as probabilistically challenged. Instead of entertaining this invitation, Jane should take full responsibility for her decision and make her best effort at ascertaining the relevant probabilities. She will do well.

Our policymakers, in turn, would also do well to put on hold the proposals urging the government to step in and fix people's probabilistic decisions.[86] This paternalism, both "soft" and invasive, is unlikely to improve people's decisions. At the same time, it may unduly suppress the creativity and heterogeneity of individuals' choices.[87]

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84. *See* pp. 249–51.

85. This maze is a mirror image of the oft-made complaint that economists can vindicate any behavior as rational. S*ee, e.g.*, RICHARD H. THALER, QUASI RATIONAL ECONOMICS xvi (1991) ("No matter how strange a particular economic action might seem to be, some economist can usually construct a rational explanation for it.").

86. *See* Cass R. Sunstein, *Empirically Informed Regulation*, 78 U. CHI. L. REV. 1349, 1362–66 (2011) (commending cautious regulatory policy that integrates free-market principles).

87. *See generally* Jeffrey J. Rachlinski, *Cognitive Errors, Individual Differences, and Paternalism*, 73 U. CHI. L. REV. 207 (2006) (arguing that government's paternalistic intervention restricting individual choice ought to be limited because deviations from rationality norms vary across individuals and groups).