11

Ending the Rationality Wars

How to Make Disputes about Human Rationality Disappear

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Blessed are the peacemakers; for they shall be called the children of God.

Matthew 5:9

1. Introduction

During the last twenty-five years, researchers who studied human reasoning and judgment in what has become known as the heuristics and biases tradition have produced an impressive body of experimental work that many have seen as having "bleak implications" for the rationality of ordinary people (Nisbett and Borgida 1975). According to one proponent of this view, when we reason about probability we fall victim to "inevitable illusions" (Piattelli-Palmarini 1994). Other proponents maintain that the human mind is prone to "systematic deviations from rationality" (Bazerman and Neale 1986) and is "not built to work by the rules of probability" (Gould 1992). It has even been suggested that human beings are "a species that is uniformly probability-blind" (Piattelli-Palmarini 1994). This provocative and pessimistic interpretation of the experimental findings has been challenged from many different directions over the years. One of the most recent and energetic of these challenges has come from the newly emerging field

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of evolutionary psychology, where it has been argued that it's singularly implausible to claim that our species would have evolved with no "instinct for probability" and, hence, be "blind to chance" (Pinker 1997, p. 351). Though evolutionary psychologists concede that it is possible to design experiments that "trick our probability calculators," they go on to claim that "when people are given information in a format that meshes with the way they naturally think about probability" (Pinker 1997, pp. 347, 351) the inevitable illusions turn out to be, to use Gerd Gigerenzer's memorable term, "evitable" (Gigerenzer 1998). Indeed, in many cases evolutionary psychologists claim that the illusions simply "disappear" (Gigerenzer 1991a).

On the face of it, the dispute between evolutionary psychology and the heuristics and biases tradition would appear to be a deep disagreement over the extent of human rationality—a conflict between two sharply divergent assessments of human reasoning. This impression is strengthened by the heated exchanges that pepper the academic literature and reinforced by steamy reports of the debate that have appeared in the popular press (Bower 1996). It is our contention, however, that the alleged conflict between evolutionary psychologists and advocates of the heuristics and biases program has been greatly exaggerated. The claims made on either side of the dispute can, we maintain, be plausibly divided into *core claims* and mere *rhetorical flourishes.*[1] And once one puts the rhetoric to one side almost all of the apparent disagreement dissolves. When one focuses on the core claims that are central to the heuristics and biases tradition and best supported by the experimental results, it turns out that these claims are not *challenged* by the evolutionary psychologists. On the contrary, some of the most intriguing avenues of research pursued by evolutionary psychologists in recent years simply make no sense unless they are interpreted as *endorsing* these central theses of the heuristics and biases tradition. Moreover, the agreement runs in the opposite direction as well. When we put aside the rhetoric of evolutionary psychologists and attend instead to their central claims about reasoning and cognitive architecture, it becomes clear that advocates of the heuristics and biases tradition have no reason at all to object to any of these claims and, in some cases, clearly should and do endorse them. Thus, we maintain that much of the dispute between evolutionary psychologists and those in the heuristics and biases tradition is itself an illusion. The fireworks generated by each side focusing on the rhetorical excesses of the other have distracted attention from what we claim is, in fact, an emerging *consensus* about the scope and limits of human rationality and about the cognitive architecture that supports it.

Our central goal in this chapter is to refocus the discussion away from the rhetoric of the debate between evolutionary psychology and the heuristics and biases tradition and toward this emerging consensus on fundamental points. To work toward this goal we will proceed as follows: In section 2, we will briefly outline the two research programs and explain what we take to be the core claims and the rhetorical excesses on both sides. Then, in section 3, we will argue that it is implausible to maintain that either research

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program rejects the core claims of the other. Once this is accomplished we think the illusion that evolutionary psychology and the heuristics and biases tradition have a deep disagreement about how rational human beings are should disappear. This is not to say, however, that there are *no* genuine disagreements between these two research programs. In the fourth section of this chapter, we briefly outline and discuss what we take to be some genuine disagreements between evolutionary psychology and the heuristics and biases tradition.

2. The Apparent Conflict

This section has two major parts. In the first half, we will begin by offering a few illustrations of the sorts of striking experimental findings that have been produced in the heuristics and biases tradition. Next, we will illustrate the sorts of explanations that those in the heuristics and biases tradition have offered for those findings. Finally, we will outline what we take to be the core claims of the heuristics and biases program and contrast them with some of the more rhetorically flamboyant claims that have been made. In the second half of this section, we start with an overview of the basic claims of evolutionary psychology and proceed on to a quick sketch of some of the experimental findings about probabilistic reasoning that evolutionary psychologists have presented. We'll then explain what we take to be the core claims of the evolutionary psychological approach to reasoning and assemble another short catalog of rhetorically flamboyant claims—this time claims about the implications of the evolutionary psychologists' results. Against this backdrop we'll go on, in the following section, to argue that despite all the colorful rhetoric, evolutionary psychologists and proponents of the heuristics and biases program don't really disagree at all about the extent to which human beings are rational or about any other claim that is central to either program.

The Heuristics and Biases Tradition: Experiments, Explanations, Core Claims, and Rhetoric

On the familiar Bayesian account, the probability of a hypothesis on a given body of evidence depends, in part, on the prior probability of the hypothesis. However, in a series of elegant experiments, D. Kahneman and A. Tversky (1973) showed that subjects often seriously undervalue the importance of prior probabilities. One of these experiments presented half of the subjects with the following "cover story":

> A panel of psychologists has interviewed and administered personality tests to 30 engineers and 70 lawyers, all successful in their respective fields. On the basis of this information, thumbnail descriptions of the 30 engineers and 70 lawyers have been written. You will find on your forms five descriptions, chosen at random from the 100 available descriptions. For each description, please indicate your probability that the person described is an engineer, on a scale from 0 to 100.

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The other half of the subjects were presented with the same text, except the "base rates" were reversed. They were told that the personality tests had been administered to seventy engineers and thirty lawyers. Some of the descriptions that were provided were designed to be compatible with the subjects' stereotypes of engineers, though not with their stereotypes of lawyers. Others were designed to fit the lawyer stereotype but not the engineer stereotype. And one was intended to be quite neutral, giving subjects no information at all that would be of use in making their decision. Here are two examples, the first intended to sound like an engineer, the second intended to sound neutral:

> Jack is a forty-five-year-old man. He is married and has four children. He is generally conservative, careful, and ambitious. He shows no interest in political and social issues and spends most of his free time on his many hobbies, which include home carpentry, sailing, and mathematical puzzles.
>
> Dick is a thirty-year-old man. He is married with no children. A man of high ability and high motivation, he promises to be quite successful in his field. He is well liked by his colleagues.

As expected, subjects in both groups thought that the probability that Jack was an engineer was quite high. Moreover, in what seems to be a clear violation of Bayesian principles, the difference in cover stories between the two groups of subjects had almost no effect at all. The neglect of base-rate information was even more striking in the case of Dick. That description was constructed to be totally uninformative with regard to Dick's profession. Thus, the only useful information that subjects had was the base-rate information provided in the cover story. But that information was entirely ignored. The median probability estimate in both groups of subjects was 50 percent.

How might we explain these results and the results of many similar experiments that have been reported in the psychological literature? The basic explanatory strategy that proponents of the heuristics and biases program have pursued is to posit the existence of reasoning heuristics: rules of thumb that we employ when reasoning. In the specific case of the preceding experiments, the hypothesis that Kahneman and Tversky offer is that in making probabilistic judgments people often rely on what they call *the representativeness heuristic*:

> Given specific evidence (e.g., a personality sketch), the outcomes under consideration (e.g., occupations or levels of achievement) can be ordered by the degree to which they are representative of that evidence. The thesis of this paper is that people predict by representativeness, that is, they select or order outcomes by the degree to which the outcomes represent the essential features of the evidence. In many situations, representative outcomes are indeed more likely than others. However, this is not always the case, because there are factors (e.g., prior probabilities of outcomes and the reliability of evidence) which affect the likelihood of outcomes but not their representativeness. Because these factors are ignored, intuitive predictions violate statistical rules of prediction in systematic and fundamental ways. (1973, p. 48)

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Though many of the reasoning problems explored in the heuristics and biases literature have no great practical importance, there are some notable exceptions. In a well-known and very disquieting study, W. Casscells, A. Schoenberger, and T. Grayboys (1978) presented the following problem to a group of faculty, staff, and fourth-year students at Harvard Medical School:

> If a test to detect a disease whose prevalence is 1/1,000 has a false positive rate of 5%, what is the chance that a person found to have a positive result actually has the disease, assuming that you know nothing about the person's symptoms or signs? ____%

Under the most plausible interpretation of the problem, the correct Bayesian answer is 2 percent. But only 18 percent of the Harvard audience gave an answer close to 2 percent. Forty-five percent of this distinguished group completely ignored the base-rate information and said that the answer was 95 percent.

What do these results and the many similar results in the heuristics and biases literature tell us about the quality of ordinary people's probabilistic reasoning and about the mental mechanisms that underlie that reasoning? Though we will return to the issue in section 3, let us grant for the time being that some of the answers that subjects provide are mistaken—that they deviate from appropriate norms of rationality. Then, since studies like those we've mentioned are both numerous and readily replicable, the following holds:

(1) people's intuitive judgments on a large number of problems that involve probability or uncertainty regularly deviate from appropriate norms of rationality.

This is clearly a core claim of the heuristics and biases program. As Kahneman and Tversky have said, "Although errors of judgment are but a method by which some cognitive processes are studied, the method has become a significant part of the message" (1982, p. 124). In addition, however, it is clear that proponents of the heuristics and biases program also endorse as a core claim a thesis about how to explain these deviations from appropriate norms of rationality, namely:

(2) Many of the instances in which our probabilistic judgments deviate from appropriate norms of rationality are to be explained by the fact that, in making these judgments, people rely on heuristics like representativeness "which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors." (Kahneman and Tversky 1973, p. 48)

Moreover, if we adopt the (standard) assumption that a cognitive mechanism or program is normatively appropriate or "correct" only to the extent that it yields normatively appropriate judgments, then, given (1) and (2), it is eminently plausible to conclude, along with P. Slovic, B. Fischhoff, and S. Lichtenstein, that "people lack the correct programs for many important judgmental tasks" (1976, p. 174).

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Slovic, Fischhoff, and Lichtenstein are not content, however, to stop with this relatively modest conclusion. Instead, they go on to make the much more sweeping claim that "[we] have not had the opportunity to evolve an intellect capable of dealing conceptually with uncertainty" (p. 174), thus suggesting not merely that we lack the correct programs for many tasks but also that, in dealing with uncertainty, we lack the correct programs for *all* judgmental tasks. In other words, they appear to be suggesting the following:

(3) The *only* cognitive tools that are available to untutored people when dealing with problems that involve probability or uncertainty are normatively problematic heuristics such as representativeness.

This expansive theme echoes passages like the following, in which Kahneman and Tversky, the founders of the heuristics and biases program, seem to endorse the view that people use representativeness and other normatively defective heuristics not just in some or many cases but in *all* cases—including those cases in which they get the right answer:

> In making predictions and judgments under uncertainty, people do not appear to follow the calculus of chance or the statistical theory of prediction. Instead, they rely on a limited number of heuristics which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors. (1973, p. 48)

In light of passages like this, it is perhaps unsurprising that both friends and foes of the heuristics and biases tradition suppose that it is committed to the claim that, as Gerd Gigerenzer has put it, "the untutored mind is running on shoddy software, that is, on programs that work *only* with a handful of heuristics" (1991b, p. 235). In another paper Gigerenzer suggests that the heuristics and biases tradition views people "as 'cognitive misers' relying on a few general heuristics due to their limited information-processing abilities" (1991a, p. 109). After describing one of Kahneman and Tversky's best-known experiments, S. Gould asks: "Why do we consistently make this simple logical error?" His answer is: "Tversky and Kahneman argue, correctly I think, that our minds are not built (for whatever reason) to work by the rules of probability" (1992, p. 469).[2]

If proponents of the heuristics and biases program would really have us believe (3), then the picture of human reasoning that they paint is bleak indeed! But should we accept this claim as anything more than mere rhetorical flourish? For several rather different reasons, we maintain that the answer is no. First, although we shall not defend this claim in detail here, it is simply not plausible to maintain that (3) is supported by the currently available experimental evidence. At *most*, what could be plausibly claimed is that we have reason to think that, in *many* instances, human beings use normatively defective heuristics. The further claim that these normatively problematic heuristics are the *only* cognitive tools that untutored folk have available is vastly stronger than anything the available evidence will support. Second, when they are being careful about what they say, leading advocates

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of the heuristics and biases program make it clear that they do not endorse (3). Thus, for example, Kahneman and Tversky state very clearly that the use of normatively problematic heuristics "does not preclude the use of other procedures" and insist that the currently available data do not support (3) but only the "more moderate hypothesis that intuitive predictions and probability judgments are highly sensitive to representativeness" (Tversky and Kahneman 1983, p. 88). This, of course, is entirely compatible with the suggestion that in many circumstances we use methods other than normatively problematic heuristics. Finally, as will become apparent in the remainder of this chapter, the heuristics and biases account of human reasoning does not presuppose a commitment to (3). It is not a central element in the heuristics and biases research program.

Evolutionary Psychology: Theory, Data, Core Claims, and Rhetoric

Though the interdisciplinary field of evolutionary psychology is too new to have developed any precise and widely agreed upon body of doctrine, there are three basic theses that are clearly central. The first is that the mind contains a large number of special-purpose systems—often called modules or mental organs. These modules are invariably conceived of as a type of computational mechanism: namely, computational devices that are specialized or domain-specific. Many evolutionary psychologists also urge that modules are both innate and present in all normal members of the species. While this characterization of modules raises lots of interesting issues—issues about which we have had a fair amount to say elsewhere (Samuels forthcoming; Samuels, Stich, and Tremoulet forthcoming)—in this chapter we propose to put them to one side. The second central thesis of evolutionary psychology is that, contrary to what has been argued by Fodor (1983) and others, the modular structure of the mind is not restricted to input systems (those responsible for perception and language processing) and output systems (those responsible for producing actions). According to evolutionary psychologists, modules also subserve many so-called central capacities, such as reasoning and belief fixation.[3] The third thesis is that mental modules are *adaptations*—they were, as J. Tooby and L. Cosmides have put it, "invented by natural selection during the species' evolutionary history to produce adaptive ends in the species' natural environment" (1995, p. xiii). Here is a passage in which Tooby and Cosmides offer a particularly colorful statement of these central tenets of evolutionary psychology:

> Our cognitive architecture resembles a confederation of hundreds or thousands of functionally dedicated computers (often called modules) designed to solve adaptive problems endemic to our hunter-gatherer ancestors. Each of these devices has its own agenda and imposes its own exotic organization on different fragments of the world. There are specialized systems for grammar induction, for face recognition, for dead reckoning, for construing objects and for recognizing emotions from the face. There are mechanisms to detect animacy, eye direction, and cheating. There is a

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> "theory of mind" module . . . a variety of social inference modules . . . and a multitude of other elegant machines. (1995, p. xiv)

If much of central cognition is indeed subserved by cognitive modules that were designed to deal with the adaptive problems posed by the environment in which our primate forebears lived, then we should expect that the modules responsible for reasoning would do their best job when information is provided in a format similar to the format in which information was available in the ancestral environment. And, as Gigerenzer has argued, though there was a great deal of useful probabilistic information available in that environment, this information would have been represented "as frequencies of events, sequentially encoded as experienced—for example, 3 *out of* 20 as opposed to 15 percent or $p = 0.15$" (1994, p. 142). Cosmides and Tooby make much the same point as follows:

> Our hominid ancestors were immersed in a rich flow of observable frequencies that could be used to improve decision-making, given procedures that could take advantage of them. So if we have adaptations for inductive reasoning, they should take frequency information as input. (1996, pp. 15–16)

On the basis of such evolutionary considerations, Gigerenzer, Cosmides, and Tooby have proposed and defended a psychological hypothesis that they refer to as the *Frequentist Hypothesis*: ". . . some of our inductive reasoning mechanisms do embody aspects of a calculus of probability, but they are designed to take frequency information as input and produce frequencies as output" (Cosmides and Tooby 1996, p. 3).

This speculation led Cosmides and Tooby to pursue an intriguing series of experiments in which the Harvard Medical School problem used by Casscells, Schoenberger, and Grayboys was systematically transformed into a problem in which both the input and the response required were formulated in terms of frequencies. Here is one example from their study in which frequency information is made particularly salient:

> 1 out of every 1,000 Americans has disease X. A test has been developed to detect when a person has disease X. Every time the test is given to a person who has the disease, the test comes out positive. But sometimes the test also comes out positive when it is given to a person who is completely healthy. Specifically, out of every 1,000 people who are perfectly healthy, 50 of them test positive for the disease.
>
> Imagine that we have assembled a random sample of 1,000 Americans. They were selected by lottery. Those who conducted the lottery had no information about the health status of any of these people.
>
> Given the information above: on average, how many people who test positive for the disease will *actually* have the disease? ____out of ____.

In sharp contrast to the original Casscells experiment, in which only 18 percent of subjects gave the correct Bayesian response, this problem elicited the correct Bayesian answer from 76 percent of Cosmides and Tooby's subjects. Nor is this an isolated case in which "frequentist versions" of

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probabilistic reasoning problems elicit high levels of performance. On the contrary, it seems that in many instances, when problems are framed in terms of frequencies rather than probabilities, subjects tend to reason in a normatively appropriate manner (Gigerenzer 1991a, 1996; Kahneman and Tversky 1996; Tversky and Kahneman 1983). Though it remains contentious how precisely to explain this fact, the phenomenon itself is now generally accepted by evolutionary psychologists and proponents of heuristics and biases alike.

It is still a matter of some controversy what precisely results of this sort show about the nature and extent of human rationality. What is clear, however, is that evolutionary psychologists take them to suggest the truth of two claims. First, they clearly think the data suggest the following:

(4) There are many reasoning problems that involve probability or uncertainty on which people's intuitive judgments *do not* deviate from appropriate norms of rationality.

Specifically, for many problems involving frequencies we reason in a normatively appropriate fashion (Cosmides and Tooby 1996; Gigerenzer 1991a, 1996). Moreover, evolutionary psychologists clearly think that the results cited earlier also provide some support for the following thesis:

(5) Many of the instances in which our probabilistic judgments accord with appropriate norms of rationality are to be explained by the fact that, in making these judgments, we rely on mental modules that were designed by natural selection to do a good job at nondemonstrative reasoning when provided with the sort of input that was common in the environment of evolutionary adaptation (EEA).

So, for example, as we have already seen, evolutionary psychologists maintain that the mind contains one or more frequentist modules that have been designed by natural selection and tend to produce normatively appropriate judgments when provided with the appropriate input. We take it that (4) and (5) are core claims of the evolutionary psychological research on probabilistic reasoning.

Like their heuristics and biases counterparts, however, evolutionary psychologists have also on occasion issued exuberant proclamations that go well beyond the core claims of the research program and cannot plausibly be viewed as anything other than rhetorical excess. In particular, evolutionary psychologists sometimes appear to maintain the following:

(6) Our probabilistic reasoning is subserved by "elegant machines" designed by natural selection and any concerns about systematic irrationality are unfounded.

This view is suggested in numerous passages in the evolutionary psychology literature. Moreover, these rhetorical flourishes tend to suggest, in our view incorrectly, that evolutionary psychology poses a direct challenge to the heuristics and biases tradition. Thus, for example, the paper in which

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Cosmides and Tooby reported their data on the Harvard Medical School problem appeared with the title "Are Humans Good Intuitive Statisticians after All? Rethinking Some Conclusions from the Literature on Judgment under Uncertainty." Five years earlier, while Cosmides and Tooby's research was still in progress, Gigerenzer reported some of their early findings in a paper with the provocative title "How to Make Cognitive Illusions Disappear: Beyond 'Heuristics and Biases.'" The clear suggestion, in both of these titles, is that the findings they report pose a head-on challenge to the pessimism of the heuristics and biases tradition and to its core claim that human beings are prone to systematic deviations from appropriate norms of rationality. Nor were these suggestions restricted to titles. In paper after paper, Gigerenzer has said things like "we need not necessarily worry about human rationality" (1998b, p. 280); "more optimism is in order" (1991b, p. 245); and "Keep distinct meanings of probability straight, and much can be done—cognitive illusions disappear" (1991b, p. 245), and he has maintained that his view "supports intuition as basically rational" (1991b, p. 242). Since comments like these are widespread in the literature, it is hardly surprising that many observers have concluded that the view of the mind and of human rationality proposed by evolutionary psychologists is fundamentally at odds with the view offered by proponents of the heuristics and biases program.

3. Making the Dispute Disappear

So far we've outlined in broad strokes the dispute between evolutionary psychology and the heuristics and biases tradition. If we are to believe the rhetoric, then it would appear that these two research programs are locked in a deep disagreement over the nature and extent of human rationality. However, in this section we propose to argue that the air of apparent conflict between evolutionary psychology and the heuristics and biases program is, in large part, an illusion engendered by a failure to distinguish the core claims of the two research programs from the rhetorical embellishments to which advocates on both sides occasionally succumb. We'll argue that once one puts the rhetoric aside and tries to formulate the dispute in more precise terms, it becomes clear that there is much less disagreement here than meets the eye. To defend this surprising contention, we need to start by drawing some distinctions. In particular, we need to distinguish between (1) a variety of proposals about *what* precisely is being assessed (what the *objects of epistemic evaluation* are) in the psychological literature on rationality and (2) a range of proposals about the *standards* (the normative yardsticks) against which epistemic evaluations should be made. With these distinctions in hand, we will then argue that on any plausible understanding of the dispute over the extent of human rationality between evolutionary psychology and the heuristics and biases tradition there is, in fact, no genuine disagreement. Though the rhetoric would suggest otherwise, evolutionary psychologists and their heuristics and biases counterparts are in substantial *agreement* over the extent to which human beings are rational.

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TABLE 11.1. Eight different kinds of epistemic evaluation

	Judgments	Mechanisms
"Standard picture"		
Accuracy in the actual domain		
Accuracy in the proper domain		
Optimal given relevant constraints		

The Objects and Standards of Epistemic Evaluation

In order to make an epistemic evaluation, one must adopt—perhaps explicitly but more often than not implicitly—positions on the following two issues: First of all, one needs to make assumptions about *what* exactly is being assessed—what the *objects* of epistemic evaluation are. In the dispute between evolutionary psychologists and advocates of the heuristics and biases tradition, there are at least two kinds of entity that might plausibly be construed as the objects of evaluation. One option is that the researchers are aiming to assess the *judgments* that subjects make—for example, the answer "95 percent" in response to the Harvard Medical School problem. If this is what is being evaluated, then it might be that the disagreement between evolutionary psychology and the heuristics and biases tradition concerns the extent to which human *judgments* about probability are normatively problematic. A second option is that psychologists who study human reason are aiming to assess the *cognitive mechanisms* that produce these judgments. In that case, the disagreement might concern the extent to which these *mechanisms* are normatively problematic.

Second, in addition to making assumptions about *what* is being assessed, the task of epistemic evaluation also requires that one adopt, if only implicitly, some *normative standard*—some yardstick—against which the evaluation is to be made. As we see it, there have been four main kinds of normative standard that have been invoked in the debate between evolutionary psychology and the heuristics and biases tradition:

1. What E. Stein (1996) calls the "standard picture"
2. Two accuracy-based normative standards:
   (a) Accuracy in the actual domain of a cognitive mechanism
   (b) Accuracy in the proper domain of a cognitive mechanism
3. An optimality-based normative standard

We will soon elaborate on these epistemic standards in some detail. For the moment, however, we wish merely to point out that when we combine them with the two objects of epistemic evaluation mentioned earlier, we can gen-

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erate a 2 × 4 array of options (see Table 11.1); there are eight different kinds of epistemic evaluation that need to be kept distinct. In the remainder of this section we will argue that for each of these options there is no genuine disagreement between evolutionary psychologists and psychologists in the heuristics and biases tradition.

The Standard Picture

When evaluating human reasoning, both evolutionary psychologists and proponents of the heuristics and biases program typically presuppose what Stein has called the standard picture of rationality:

> According to this picture, to be rational is to reason in accordance with principles of reasoning that are based on rules of logic, probability theory and so forth. If the standard picture of reasoning is right, principles of reasoning that are based on such rules are normative principles of reasoning, namely they are the principles we ought to reason in accordance with. (1996, p. 4)

Thus, the standard picture maintains that the appropriate criteria against which to evaluate human reasoning are the rules derived from formal theories such as classical logic, probability theory, and decision theory.[4] So, for example, one might derive something like the following principle of reasoning from the conjunction rule of probability theory:

> *Conjunction Principle*
> One ought not assign a lower degree of probability to the occurrence of event A than one does to the occurrence of A and some (distinct) event B. (Stein 1996, p. 6)

Given principles of this kind, one can evaluate the specific judgments issued by human subjects and the mechanisms that produce them. To the extent that a person's judgments accord with the principles of the standard picture these judgments are rational, and to the extent that they violate such principles the judgments fail to be rational. Similarly, to the extent that a reasoning mechanism produces judgments that accord with the principles of the standard picture the mechanism is rational, and to the extent that it fails to do so it is not rational. As M. Piattelli-Palmarini puts the point:

> The universal principles of logic, arithmetic, and probability calculus . . . tell us what we *should* . . . think, not what we in fact think. . . . If our intuition does in fact lead us to results incompatible with logic, we conclude that our intuition is at fault. (1994, p. 158)

THE STANDARD PICTURE AND THE EVALUATION OF JUDGMENTS Proponents of the heuristics and biases program often appear to be in the business of evaluating the intuitive *judgments* that subjects make against the yardstick of the standard picture. As we noted earlier, Kahneman and Tversky say that "although errors of judgment are but a method by which some cognitive processes are studied, the method has become a significant

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part of the message" (1982, p. 124). And the method-turned-message appears to be that many of our probabilistic judgments *systematically* deviate from the norms of rationality prescribed by the standard picture, specifically from those norms derived from probability theory (Kahneman and Tversky 1972, p. 431; Piatelli-Pallmarini 1994, p. 140). A recurrent theme in the heuristics and biases literature is that many of our intuitive judgments about probabilities deviate from the canons of probability theory in such a way that the deviations can be reliably reproduced under a wide range of circumstances that are related in their possession of certain key characteristics—for example, the manner in which information is presented to people or the content of the information about which people are asked to reason.

At first sight, this would appear to be a claim that evolutionary psychologists reject. Thus, Gigerenzer asserts that "most so-called errors or cognitive illusions are, contrary to the assertions of the literature, in fact *not* violations of probability theory" (1991a, p. 86). But on closer scrutiny, it is hard to see how evolutionary psychologists *could* reject the claim that many of our intuitive judgments systematically deviate from norms derived from probability theory. This is because some of the central features of their research program commit them to saying that human judgments *do* systematically deviate from these norms. In order to make this point we will focus on two features of the evolutionary psychological research program: (1) the empirical thesis that formulating probabilistic problems in terms of frequencies improves performance and (2) the ameliorative project of improving statistical reasoning by teaching subjects to reformulate probabilistic problems in terms of frequencies.

As we saw in section 2, evolutionary psychologists maintain that when problems are explicitly formulated in terms of frequencies performance improves dramatically. Consider, for example, the experiments on base-rate neglect. We have already discussed the Casscells study's Harvard Medical School problem and noted that it appears to show that, under certain circumstances, human beings systematically ignore information about base rates when performing diagnostic tasks (Cascells, Schoenberger, and Grayboys 1978). For our current purposes, the crucial point to notice about the Casscells et al. experiment is that the problem was formulated in a *nonfrequentist* format. Subjects were asked about the probability of single events—the probability that a *specific* person has a disease—and were provided with probabilistic information in percentile and decimal formats. The results were disconcerting: 82 percent of subjects failed to provide the appropriate Bayesian answer to the problem. By contrast, we have already seen that, when presented with variants of the Harvard Medical School problem in which frequencies rather than percentages and single event probabilities were emphasized, subjects performed far better than they did in the original Cascells experiment. Although a number of different factors affect performance, according to Cosmides and Tooby, two predominate: "Asking for the answer as a frequency produces the largest effect, followed closely by presenting the problem information as frequencies" (1996, p. 58).

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One central conclusion that evolutionary psychologists have wanted to draw from these experiments is that human probabilistic judgment *improves when problems are reformulated in terms of frequencies.*[5] So, for example, Cosmides and Tooby claim that "good statistical reasoning reappears, when problems are posed in frequentist terms" (1996, p. 62). This, however, poses a serious problem for the view that evolutionary psychologists reject the heuristics and biases thesis that human beings perform poorly in many judgmental tasks that involve probabilities. After all, it's hard to make sense of the claim that probabilistic judgment *improves* or that good statistical reasoning *reappears* in frequentist tasks unless performance on nonfrequency problems was *poor*, or at any rate less good, in the first place. Moreover, it is clear that the metric that evolutionary psychologists are employing in order to evaluate whether or not probabilistic judgment improves is precisely the same as the one adopted by proponents of the heuristics and biases program: namely, the standard axioms and theorems of probability theory. It is precisely *because* judgments on many frequentist tasks accord with Bayes's theorem (and judgments on nonfrequentist tasks do not) that Cosmides and Tooby claim that good statistical reasoning reappears when problems are posed in terms of frequencies. The interpretation that evolutionary psychologists impose on their own experimental data—namely, that performance improves in frequentist tasks—*commits* them to accepting the heuristics and biases thesis that many of our probabilistic judgments deviate from appropriate norms of probabilistic reasoning.

A similar point applies to another central feature of evolutionary psychological research on human reasoning—the ameliorative project of trying to improve human probabilistic inference. In addition to providing empirical hypotheses about the cognitive mechanisms responsible for inductive reasoning, evolutionary psychologists have also been concerned with trying to improve the quality of probabilistic inference. This practical project has been vigorously pursued by Gigerenzer and his colleagues. And in a series of papers with titles such as "How to Improve Bayesian Reasoning without Instruction: Frequency Formats" and "How to Improve Diagnostic Inferences in Physicians" they have shown how probabilistic judgment can be improved by teaching subjects to convert problems into a frequentist format (Gigerenzer and Hoffrage 1995; Hoffrage, Gigerenzer, and Ebert in press). So, for example, Gigerenzer and his colleagues suggest that if physicians convert diagnostic problems into a frequentist format, then they are more likely to be accurate in their diagnoses.

This sort of ameliorative project, once again, poses a serious problem for the contention that evolutionary psychologists reject the heuristics and biases thesis that human beings perform poorly in many judgmental tasks that involve probabilities. For it is extremely hard to see how we can make sense of the idea that performance can be *improved* by converting problems into a frequency format *unless subjects were previously doing something wrong.* If there was nothing wrong, for example, with the answers that physicians provided to diagnostic problems that were formulated in nonfrequentist terms, then diagnosis *couldn't* be improved by formulating the problem in a

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TABLE 11.2. Kinds of epistemic dispute narrowed to seven options

	Judgments	Mechanisms
"Standard picture"	*no dispute*	
Accuracy in the actual domain		
Accuracy in the proper domain		
Optimal given relevant constraints		

frequentist format.[6] This is, we think, an entirely uncontroversial conceptual point. According to conventional wisdom, "If it ain't broken, don't fix it." Our point is rather more basic: if it ain't broken, you *can't* fix it.

It is hard, then, to sustain the view that evolutionary psychologists reject the claim that many of our probabilistic judgments deviate from the norms of probability theory. What about a disagreement in the other direction? Do proponents of the heuristics and biases tradition deny the evolutionary psychologists' claim that many of our intuitive judgments about probability *accord* with the principles of probability theory? This is a suggestion that is hard to take seriously in the light of overwhelming textual evidence to the contrary. Kahneman, Tversky, and other advocates of the heuristics and biases program note repeatedly that normatively problematic heuristics like "representativeness" often get the *right* answer. Moreover, Kahneman and Tversky maintain (correctly) that they were responsible for discovering that formulating many judgmental problems in terms of frequencies leads to a dramatic improvement in performance (1996). And, as we'll see later on, they have also attempted to explain this phenomenon by providing an analysis of how the "extensional cues" provided by frequentist formulations of probabilistic problems facilitate reasoning. It is, therefore, singularly implausible to maintain that proponents of heuristics and biases deny that there are many probabilistic problems in which subjects' judgments accord with the probability calculus. We conclude that if there is a dispute between evolutionary psychologists and proponents of heuristics and biases, it is not located in the first box in Table 11.1. So it is time to replace Table 11.1 with Table 11.2.

THE STANDARD PICTURE AND THE EVALUATION OF MECHANISMS If there is no substantive disagreement between evolutionary psychologists and proponents of the heuristics and biases tradition over whether or not our probabilistic *judgments* accord with the principles of the standard picture, then perhaps a disagreement exists over whether or not the cognitive *mechanisms* that subserve probabilistic reasoning accord with these principles? Certainly much of what has been said by participants in the debate suggests such a disagreement. Thus, for example, Cosmides and

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Tooby explicitly represent their project as a challenge to what they see as "the conclusion most common in the literature on judgment under uncertainty —that our inductive reasoning mechanisms do not embody a calculus of probability" (1996, p. 1). But when one considers the issue more carefully it becomes difficult to sustain the view that there is any genuine disagreement here—or so we shall argue.

In order to defend this claim, we'll start by arguing that the positive accounts of probabilistic reasoning that evolutionary psychologists and proponents of heuristics and biases have developed are not incompatible. Indeed, rather than being incompatible, the views that have emerged from these two research programs about the nature of probabilistic reasoning mechanisms are to a surprising degree complementary. For while the heuristics and biases program has been primarily concerned with finding cases where subjects do a bad job in their probabilistic reasoning and proposing mechanisms to explain these shortcomings, evolutionary psychologists have been more concerned with positing mechanisms in order to explain those instances in which our probabilistic reasoning is normatively unproblematic. In short, the two research programs have simply focused on different phenomena.

Evolutionary psychologists have endorsed a range of claims about the mechanisms that subserve probabilistic inference in human beings. One often-repeated claim is that the human mind contains a "multitude of elegant machines" for inductive reasoning: "many different ones, each appropriate to a different kind of decision-making problem" (Cosmides and Tooby 1996, p. 63). Moreover, evolutionary psychologists contend that at least some of these mechanisms—specifically, frequentist mechanisms—are normatively appropriate relative to precisely the same standard that the heuristics and biases program endorses, namely, their input-output patterns match what would be required by the Bayesian theory of probability. Thus, Cosmides and Tooby suggest that "people do have reliably developing mechanisms that allow them to apply the calculus of probability" (1996, p. 18).

It is important to stress, however, that these frequentist mechanisms are supposed to be *format-restricted*; they are only able to process information that is presented in the appropriate format. More specifically, frequentist mechanisms "are designed to accept probabilistic information when it is in the form of a frequency, and to produce a frequency as their output" (Cosmides and Tooby 1996, p. 18). When probabilistic problems are presented in a nonfrequentist format, however, evolutionary psychologists contend that our judgments will deviate from those prescribed by the calculus of probability because the frequentist mechanisms will be unable to process the information.[7] In short: according to evolutionary psychology, whether or not our probabilistic reasoning mechanisms produce judgments that accord with the probability calculus depends crucially on the format in which the information is presented.

The previous two paragraphs provide a brief description of the main *positive* theses that evolutionary psychologists endorse about probabilistic

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inference in humans. But it is important to stress that this cannot be the entire story. Nor, for that matter, do evolutionary psychologists suggest that it is. Indeed, they *insist* that we may well need to posit a wide range of other inductive mechanisms, each of which operates according to different principles, in order to explain human reasoning (Cosmides and Tooby 1996, p. 63). One class of phenomena that is clearly in need of explanation is that of those instances in which subjects respond to probabilistic problems in ways that deviate from the norms of the probability calculus. These responses are not random but systematic in character. And presumably a complete account of human probabilistic reasoning needs to explain the inferential patterns that occur when we deviate from the probability calculus as well as those that occur when we get things right. Though evolutionary psychologists clearly accept this point and are prepared to posit additional mechanisms in order to explain the results, they have, as yet, provided no detailed theory that accounts for these results.[8] Nevertheless, they require an explanation. And presumably the explanation will need to invoke mechanisms in addition to the frequentist mechanisms discussed earlier. Moreover, these additional mechanisms will not map inputs onto the same outputs that the probability calculus would and, hence, *they will be normatively problematic by the lights of the standard picture.*

Is there any reason to think that proponents of the heuristics and biases program would or should disagree with any of this? As far as we can see, the answer is no. First of all, it is important to see that, according to the preceding picture of our reasoning architecture, the total system will yield lots of mistakes, though it will also yield lots of correct answers. And this is entirely consistent with the heuristics and biases account. Moreover, proponents of the heuristics and biases program will clearly not want to reject the claim that we possess cognitive mechanisms that *fail* to produce the input-output mappings that are sanctioned by the probability calculus. That there are such mechanisms is a central claim of the heuristics and biases approach to human probabilistic reasoning. Indeed, it would appear that the positive views that evolutionary psychologists endorse about the nature of our reasoning architecture are consistent with the claim that the systems responsible for producing non-Bayesian judgments employ the sorts of heuristics that Kahneman, Tversky, and their followers have invoked in order to explain deviations from the probability calculus. So, for example, it may be the case that some of the normatively problematic mechanisms that evolutionary psychologists must posit to explain normatively problematic judgments implement the representativeness and availability heuristics.

At this point it might be suggested that proponents of the heuristics and biases program reject the existence of mechanisms that operate according to principles of the probability calculus. This could be because either (1) they reject the existence of more than one reasoning mechanism or (2) while they accept the existence of more than one reasoning mechanism, they deny that any of them operate according to the principles of probability. Let's consider these options in turn.

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Evolutionary psychologists sometimes appear to suggest that proponents of the heuristics and biases program are wedded to the assumptions that there are no domain-specific or modular mechanisms for reasoning and that all reasoning is subserved by general-purpose processes and mechanisms. So, for example, Cosmides and Tooby appear to attribute to the heuristics and biases program "a certain old-fashioned image of the mind: that it has the architecture of an early model, limited-resource general-purpose computer" (1996, p. 13). There is plenty of textual evidence, however, that proponents of the heuristics and biases program do not endorse such a picture of the mind. So, for example, in a passage that anticipates a central theme in the work of evolutionary psychologists, Kahneman and Tversky compare the processes involved in the solving of probabilistic problems "with the operation of a flexible computer program that incorporates a variety of potentially useful subroutines" (1983, p. 88).[9] Elsewhere, they are even more explicit on the matter and claim that "the actual reasoning process is schema-bound or content-bound so that different operations or inferential rules are available in different contexts" and that "consequently, human reasoning cannot be adequately described in terms of content-independent formal rules" (Tversky and Kahneman 1983, p. 499). Piattelli-Palmarini is still more explicit in his endorsement of a domain-specific conception of human reasoning and goes so far as to suggest (rightly or wrongly) that judgmental errors are "a demonstration of what modern cognitive science calls the 'modularity' of the mind" (1994, p. 32). In other words, Piattelli-Palmarini appears to be endorsing the claim that we possess modules for reasoning.

So proponents of the heuristics and biases program do not appear to be adverse to the idea that human reasoning is subserved by a variety of domain-specific cognitive mechanisms. Do they, perhaps, deny that any of these mechanisms operate according to the principles of the probability calculus? If they did maintain this position, then there would be a genuine disagreement between evolutionary psychologists and proponents of the heuristics and biases program. But there is, in fact, no reason to suppose that they do hold such a view. First of all, nowhere in the heuristics and biases literature have we been able to find a single passage in which it is *explicitly* denied that we possess some cognitive mechanisms that operate according to the principles of the probability calculus. What we do find, however, are passages that may be interpreted as *suggesting* that there are no such mechanisms. So, for example, as we noted earlier, Kahneman and Tversky (1973) claim that

> in making predictions and judgments under uncertainty, people do not appear to follow the calculus of chance or the statistical theory of prediction. Instead, they rely on a limited number of heuristics which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors. (p. 48)

This and other similar passages in the heuristics and biases literature might be thought to have the conversational implicature that we *only* use

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normatively problematic heuristics in our probabilistic reasoning and hence possess no reasoning mechanisms that operate according to the principles of the probability calculus.

We maintain, however, that there are extremely good reasons to treat such claims as instances of rhetorical excess. First, as we pointed out in section 2, the claim that we possess *no* normatively unproblematic mechanisms for probabilistic reasoning is clearly not supported by the available empirical evidence. Such a claim is vastly stronger than anything the available evidence will support. And this provides us with some reason to treat it as a rhetorical flourish rather than a core claim of the heuristics and biases research program.

Second, all the quotations from the heuristics and biases literature we have found that suggest humans possess no normatively appropriate reasoning mechanisms manifest a tendency that Kahneman and Tversky have themselves lamented—the tendency to overstate one's position by "omitting relevant quantifiers" (1996, p. 589). Kahneman and Tversky raise this point in response to Gigerenzer's claim that cognitive illusions disappear when problems are formulated in terms of frequencies. They suggest that "because Gigerenzer must be aware of the evidence that judgments of frequency . . . are subject to systematic error, a charitable interpretation of his position is that he has overstated his case by omitting relevant quantifiers" (1996, p. 589). We maintain that much the same may be said of the position that Kahneman, Tversky, and their followers sometimes appear to endorse regarding the normative status of our reasoning mechanisms. Consider, for example, the preceding quotation from Kahneman and Tversky 1973. The natural reading of this passage is that Kahneman and Tversky are claiming that humans *always* "rely on a limited number of heuristics" (1973, p. 48). But notice that the relevant quantifier is omitted. It is left unspecified whether they are claiming that we *always* use normatively problematic heuristics rather than (for example) claiming that we *typically* or *often* use such heuristics. And because they must know that the truth of the natural reading is vastly underdetermined by the data, it is surely charitable to interpret this as an instance of rhetorical excess—an overstatement of their position that results from omitting relevant quantifiers. Moreover, this point generalizes: in *all* the passages from the heuristics and biases literature that we have found which suggest that humans possess no normatively appropriate reasoning mechanisms, *relevant quantifiers are systematically omitted.* We suggest, therefore, that because proponents of the heuristics and biases program are presumably aware that the available evidence fails to support the claim that humans possess *no* normatively unproblematic reasoning mechanisms, the charitable interpretation of these quotations is that they overstate the position by omitting relevant quantifiers.

A final point that further supports the conclusion of the previous paragraph is that in their more reflective moments—when quantifiers are not omitted—advocates of the heuristics and biases tradition make it clear that they are not maintaining that we *always* use normatively problematic heuristics and mechanisms in our intuitive reasoning. Instead, they explicitly claim

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TABLE 11.3. Kinds of epistemic dispute narrowed to six options

	Judgments	Mechanisms
"Standard picture"	*no dispute*	*no dispute*
Accuracy in the actual domain		
Accuracy in the proper domain		
Optimal given relevant constraints		

only that we *sometimes* or *often* use such heuristics and mechanisms. So, for example, when they are being careful, Kahneman and Tversky claim only that "intuitive predictions and judgments are *often* mediated by a small number of distinct mental operations . . . [or] . . . judgmental heuristics" (1996, p. 582). But this position is entirely compatible with the evolutionary psychological view that we also possess some normatively unproblematic reasoning mechanisms. In short: when proponents of the heuristics and biases tradition express their views carefully and fill in the appropriate quantifiers, they end up maintaining a position about the normative status of our reasoning mechanisms that does not conflict with the claims of evolutionary psychologists. It is time, then, to replace Table 11.2 with Table 11.3.

Accuracy-Based Assessments

Though the standard picture is the normative yardstick most commonly invoked in the dispute between evolutionary psychology and the heuristics and biases program, it is not the only one. Another kind of normative standard is suggested by Gigerenzer's discussion of Take The Best and other members of a class of satisfying algorithms that he calls fast and frugal procedures (Gigerenzer and Goldstein 1996; Gigerenzer, Hoffrage, and Kleinbölting 1991). According to Gigerenzer, a central consideration when evaluating reasoning is its *accuracy* (Gigerenzer and Goldstein 1996, p. 665). And because fast and frugal algorithms get the correct answer at least as often as other computationally more expensive, "rational"[10] methods (such as standard statistical linear models) Gigerenzer clearly thinks that they are normatively unproblematic. Indeed, he thinks that the fact that these simple algorithms are accurate constitutes a refutation of the claim that only "rational" algorithms can be accurate and goes some way toward overcoming the "opposition between the rational and the psychological and . . . reunit[ing] the two" (Gigerenzer and Goldstein 1996, p. 666).

Although the notion of accuracy applies to both judgments and cognitive mechanisms, Gigerenzer and other evolutionary psychologists are concerned primarily with the accuracy of mechanisms (Cosmides and Tooby

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1996; Gigerenzer and Goldstein 1996). Moreover, it is also clear that once we address the issue of whether or not evolutionary psychologists and proponents of the heuristics and biases tradition disagree about the accuracy of our cognitive mechanisms, the same considerations apply *mutatis mutandis* to the putative disagreement over judgments. For this reason we will focus primarily on whether or not there is any genuine disagreement between evolutionary psychology and the heuristics and biases program over the accuracy of our cognitive mechanisms.

When applied to cognitive mechanisms, Gigerenzer's accuracy-based criterion for epistemic evaluation bears an intimate relationship to the reliabilist tradition in epistemology according to which (very roughly) a cognitive mechanism is rational just in case it tends to produce true beliefs and avoid producing false ones (Goldman 1986; Nozick 1993).[11] One frequently observed consequence of reliabilist and accuracy-based approaches to the evaluation of cognitive mechanisms is that assessments must be relativized to some environment or domain of information (Goldman 1986; Nozick 1993; Stich 1990). A visual system, for example, is not reliable or unreliable *simpliciter* but only reliable or accurate relative to a (set of) environment(s) or a domain of information.[12] Moreover, there is an indefinitely wide range of environments or domains to which evaluations might be relativized. For current purposes, however, let's focus on two that have been suggested by D. Sperber to be particularly relevant to understanding the evolutionary psychological approach to reasoning—what he calls the *actual domain* and the *proper domain* for a cognitive mechanism (1994). The actual domain for a given reasoning module is "all the information in the organism's environment that may (once processed by perceptual modules, and possibly by other conceptual modules) satisfy the module's input conditions" (pp. 51–52). By "input conditions" Sperber means those conditions that must be satisfied in order for the module to be able to process a given item of information. So, for example, if a module requires that a problem be stated in a particular format, then any information not stated in that format fails to satisfy the module's input conditions. By contrast, the proper domain for a cognitive mechanism is all the information that it is the mechanism's "biological function to process" (p. 52). The proper domain is the information that the mechanism was designed to process by natural selection. In recent years, many philosophers of biology have come to regard the notion of a biological function as a particularly slippery one.[13] For current purposes we can rely on the following very rough characterization: the biological functions of a system are the activities or effects of the system in virtue of which the system has remained a stable feature of an enduring species.

Do evolutionary psychologists and proponents of the heuristics and biases tradition disagree about the accuracy of reasoning mechanisms in their *proper* domains? Clearly not. For while evolutionary psychologists have maintained that cognitive mechanisms will tend to perform accurately in their proper domains—on the kinds of information that they are designed to process—the heuristics and biases tradition has been entirely silent on the issue. Determining the accuracy of cognitive mechanisms *in the proper*

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domain is simply not the line of work that proponents of heuristics and biases are engaged in. So there could be no disagreement here.

It is similarly implausible to maintain that evolutionary psychologists and advocates of the heuristics and biases tradition disagree over the accuracy of our reasoning mechanisms in the *actual* domain. Clearly, evolutionary psychologists think that *some* of our reasoning mechanisms are accurate in the actual domain. But it is equally clear that they do not claim that *all* of these mechanisms are. They certainly cite no evidence that could support the claim that *all* of our reasoning mechanisms are accurate in the actual domain. And, what is more important, such a claim would be patently incompatible with their ameliorative project. If all our reasoning mechanisms are accurate in the actual domain, then there is little room for systematically *improving* human reasoning. So it must be the case that what evolutionary psychologists want to claim is that *some but not all* of our reasoning mechanisms are accurate in the actual domain.

Do proponents of the heuristics and biases tradition reject this claim? As far as we can see, the answer is no. They clearly think that *some* of our cognitive mechanisms are inaccurate in the actual domain. This, after all, is a central message of their research program. But they have been largely silent on the issue of whether or not we possess other reasoning mechanisms that are accurate in the actual domain. And this is simply because, as we mentioned earlier on, proponents of the heuristics and biases tradition have primarily focused on explaining instances of incorrect judgment rather than explaining instances of successful inference. Nonetheless, as we saw earlier, theorists working within the heuristics and biases tradition are not adverse to the idea that we have reasoning mechanisms other than the ones that employ normatively problematic heuristics and, to the extent that they say anything about these other mechanisms, they seem amenable to the idea that they may be accurate. So, for example, Kahneman and Tversky seem entirely comfortable with the idea that mechanisms that employ correct rules of probabilistic inference can produce highly accurate judgments in contexts where the problem is transparent and "extensional" cues are effective (Tversky and Kahneman 1983).

The situation is similar when we turn to the issue of whether or not evolutionary psychologists and advocates of the heuristics and biases approach disagree over the accuracy of our *judgments*. Evolutionary psychologists think that we tend to be accurate in the *proper* domain, whereas proponents of the heuristics and biases program are simply silent on the issue. And both parties appear to think that *many but not all* of our judgments are accurate in the *actual* domain. There are, of course, lots of issues of detail where the two research programs disagree. So, for example, Gigerenzer has challenged some of the interpretations that advocates of the heuristics and biases program have imposed on specific experiments. We will consider some of these cases in section 4. But we maintain that these disagreements are *merely* matters of detail and ought not to distract from the genuine consensus between evolutionary psychology and the heuristics and biases program. Both programs clearly accept that many of our judgments in the actual

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TABLE 11.4. Kinds of epistemic dispute narrowed to two options

	Judgments	Mechanisms
"Standard picture"	*no dispute*	*no dispute*
Accuracy in the actual domain	*no dispute*	*no dispute*
Accuracy in the proper domain	*no dispute*	*no dispute*
Optimal given relevant constraints		

domain are inaccurate and that we are subject to systematic errors. This is a central claim of the heuristics and biases program, and evolutionary psychology is similarly committed to this view by virtue of endorsing the ameliorative project. Moreover, neither program insists that *all* of our judgments are inaccurate. Both, for example, think that our judgments about frequency can be highly accurate. Again, there is no disagreement. So we can now replace Table 11.3 with Table 11.4.

Constrained-Optimality Assessments

A final normative standard that has been invoked by participants in the debate between evolutionary psychology and the heuristics and biases tradition is one that applies only to the evaluation of cognitive mechanisms and not to the judgments that these mechanisms produce. The standard in question maintains that a reasoning mechanism is normatively unproblematic to the extent that it is *optimal given the constraints to which it is subject.* This proposal is alluded to by Gigerenzer when he suggests that some reasoning mechanisms may be optimal in the way that Herman von Helmholtz and Richard Gregory propose that visual processing mechanisms are optimal: they are *the best systems available for acquiring an accurate picture of the world given the constraints under which they must operate.* One crucial point to stress is that the best system (given the constraints under which it operates) need not be a system that never makes mistakes. As Gigerenzer points out, such "systems can be fooled and may break down when stable, long-term properties of the environment to which they are adapted change" (1997, p. 10). So, for example, Gregory maintains that visual "illusions will be a necessary part of all efficiently designed visual machines"—even the *best-designed* visual systems (Gregory, quoted in Gigerenzer 1991a, p. 228). Similarly, Gigerenzer suggests that, given the constraints under which real cognitive systems must operate, "cognitive illusions" or "biases" will be a necessary part of an efficiently designed reasoning mechanism. Thus, the Helmholtzian view "allows both for optimal cognitive functioning and for systematic illusions" (Gigerenzer 1991a, p. 240).

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Is there any disagreement between evolutionary psychologists and proponents of the heuristics and biases program on the issue of whether or not we possess mechanisms that are optimally well designed (given the appropriate constraints) for probabilistic reasoning? Once again, we maintain, the answer is no. While evolutionary psychologists have suggested that we possess mechanisms that are optimal in the relevant sense, proponents of the heuristics and biases program need not and do not deny this claim. To see why, it is important to note that when evolutionary psychologists suggest that we possess reasoning mechanisms that are optimal given the constraints, they typically appear to have in mind the claim that we possess cognitive mechanisms that are optimally well designed for processing information in their *proper domains* (and under conditions similar to those our evolutionary ancestors would have encountered) and not the claim that we possess mechanisms that are optimally well designed for processing information in their *actual domains*. Thus, for example, Cosmides and Tooby suggest that

> our minds come equipped with very sophisticated intuitive competences that are well-engineered solutions to the problems humans normally encountered in natural environments . . . and that ecologically valid input (e.g., frequency formats) may be necessary to activate these competences. (1996, p. 9)

But if the notion of optimality invoked by evolutionary psychologists is indexed to the proper domain, then, as we have already seen, proponents of the heuristics and biases program do not disagree. The heuristics and biases program simply is not concerned with the performance of cognitive mechanisms in their proper domains.

Suppose, however, that, contrary to appearances, evolutionary psychologists do wish to maintain that we possess reasoning mechanisms that are optimal relative to the actual domain. Even so, they clearly could not maintain that *all* of our reasoning mechanisms are optimal since, once again, such a view would render their ameliorative project impossible. If all our reasoning mechanisms were the best that they could be, then we *couldn't* make them better. Here the (dis)analogy between visual systems and reasoning systems is illuminating. It is plausible to claim that when functioning normally our visual systems are optimal in the sense that they simply cannot be improved. By contrast, we *can* improve our reasoning—hence the ameliorative project. So the most that evolutionary psychologists could be claiming is that some or perhaps many of our cognitive mechanisms are optimal relative to the actual domain. But this is not a claim that proponents of the heuristics and biases tradition either do or should reject. To the best of our knowledge, proponents of the heuristics and biases program have never denied that we possess some reasoning mechanisms that are optimal in this sense. What they do deny is that *all* of the cognitive mechanisms that subserve reasoning are optimal in the sense that they always produce judgments that are correct and/or accord with the principles of the probability calculus. This, however, is a very different notion of optimality—a notion of

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TABLE 11.5. Kinds of epistemic dispute narrowed to one option

	Judgments	Mechanisms
"Standard picture"	*no dispute*	*no dispute*
Accuracy in the actual domain	*no dispute*	*no dispute*
Accuracy in the proper domain	*no dispute*	*no dispute*
Optimal given relevant constraints		*no dispute*

optimality that does not take into consideration the constraints under which our reasoning systems must operate. There is no reason to suppose that the heuristics and biases program is committed to denying that we possess cognitive mechanisms that are optimal in the actual domain *given the constraints under which they operate*. For as we have already seen, the claim that a reasoning system is optimal (given the appropriate constraints) is perfectly consistent with the view that it is subject to lots of biases and cognitive illusions. Thus, proponents of the heuristics and biases program need not and do not deny that some or even many of our cognitive mechanisms may be optimal in the Helmholtzian sense that Gigerenzer and other evolutionary psychologists have in mind. And if this correct, then we can replace Table 11.4 with Table 11.5.

4. Some Real Disagreements

The main burden of this chapter has been to dispel the illusion that there is any substantive disagreement between evolutionary psychologists and advocates of the heuristics and biases tradition concerning the extent of human rationality. We do not intend to suggest, however, that there is nothing left for evolutionary psychologists and proponents of the heuristics and biases program to disagree about. Clearly there is. Indeed, there are a number of different disputes that remain. One of these disputes focuses on the issue of how we ought to apply probability theory to specific problems in the heuristics and biases literature—for example, the lawyer/engineer problem and the Harvard Medical School problem—and whether or not probability theory provides a uniquely correct answer to these problems. Though authors in the heuristics and biases tradition often appear to assume that there is only one normatively correct answer to these problems, Gigerenzer has argued that there are typically a number of equally reasonable ways of applying probability theory to the problems and that these different analyses result in distinct but equally correct answers (1991a, 1994).

Another very real dispute concerns the adequacy of the explanations proposed by proponents of the heuristics and biases tradition—explanations that invoke heuristics, such as availability and representativeness, in order to explain cognitive phenomena. Evolutionary psychologists have main-

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tained that these "heuristics are too vague to count as explanations" and that psychologists who work in the heuristics and biases tradition have failed to "specify precise and falsifiable process models, to clarify the antecedent conditions that elicit various heuristics, and to work out the relationship between heuristics." (Gigerenzer 1996, p. 593). Proponents of the heuristics and biases tradition have responded by arguing that evolutionary psychologists have "missed the point" (Kahneman and Tversky 1996). They maintain that representativeness and other heuristics "can be assessed experimentally" and that testing the hypothesis that probability judgments are mediated by these heuristics "does not require a theoretical model" (Kahneman and Tversky 1996).

On our view, both of these disputes raise deep and interesting questions, which we plan to address elsewhere. In this section we propose to focus on a third very real dispute between evolutionary psychologists and proponents of the heuristics and biases tradition, one that has often been center stage in the literature. This is the disagreement over what interpretation of probability theory to adopt.

There has been a long-standing disagreement between proponents of the heuristics and biases program and evolutionary psychologists over what we should recognize as the correct interpretation of probability theory. In contrast with psychologists in the heuristics and biases tradition, Gigerenzer has urged that probability theory ought to be given a frequentist interpretation according to which probabilities are construed as relative frequencies of events in one class to events in another. As Gigerenzer points out, according to "this frequentist view, one cannot speak of a probability unless a reference class is defined" (1993, pp. 292–293). So, for example, "the relative frequency of an event such as death is only defined with respect to a reference class such as 'all male pub-owners fifty-years old living in Bavaria'" (Gigerenzer 1993, p. 292). One consequence of this that Gigerenzer is particularly keen to stress is that according to frequentism, *it makes no sense* to assign probabilities to single events. Claims about the probability of a single event are *literally meaningless*: "For a frequentist . . . the term "probability," when it refers to a *single event*, has no meaning at all for us" (1991a, p. 88). Moreover, Gigerenzer maintains that because of this "a strict frequentist" would argue that "the laws of probability are about frequencies and not about single events" and, hence, that "no judgment about single events can violate probability theory" (1993, pp. 292–293).

In stark contrast with Gigerenzer's frequentism, Kahneman, Tversky, and their followers insist that probability theory *can* be meaningfully applied to single events and hence that judgments about single events (e.g., Jack being a engineer or, in another well-known problem, Linda being a bank teller)[14] can violate probability theory. This disagreement emerges very clearly in Kahneman and Tversky's 1996 work, where they argue that Gigerenzer's treatment of judgment under uncertainty "appears far too restrictive" because it "does not apply to events that are unique for the individual and, therefore, excludes some of the most important evidential and decision problems in people's lives" (p. 589). Instead of adopting frequentism, Kahneman

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and Tversky suggest that some "subjectivist" or "Bayesian" account of probability may be preferable.

This disagreement over the interpretation of probability raises complex and important questions in the foundations of statistics and decision theory about the scope and limits of our formal treatment of probability. Moreover, the dispute between frequentists and subjectivists has been a central debate in the foundations of probability for much of the twentieth century (Mises 1957; Savage 1972). Needless to say, a satisfactory treatment of these issues is beyond the scope of this chapter. But we would like to comment briefly on what we take to be the central role that issues about the interpretation of probability theory play in the dispute between evolutionary psychologists and proponents of the heuristics and biases program. In particular, we will argue that Gigerenzer's use of frequentist considerations in this debate is deeply problematic.

Questions about the interpretation of probability entered the debate between evolutionary psychology and the heuristics and biases tradition primarily because it was realized by some theorists—most notably Gigerenzer—that these questions bear on the issue of whether or not human reasoning violates appropriate norms of rationality. As we have already seen, Gigerenzer argues that if frequentism is true, then statements about the probability of single events are meaningless and, hence, that judgments about single events *cannot* violate probability theory (1993, pp. 292–293). Gigerenzer clearly thinks that this conclusion can be put to work in order to dismantle part of the evidential base for the claim that human judgments and reasoning mechanisms violate appropriate norms. For as we have seen, participants in the debate between evolutionary psychology and the heuristics and biases tradition typically view probability theory as the source of appropriate normative constraints on probabilistic reasoning. And if frequentism is true, then no probabilistic judgments about single events will be normatively problematic (by this standard), since they will not violate probability theory. In which case, Gigerenzer gets to exclude all experimental results that involve judgments about single events as evidence for the existence of normatively problematic, probabilistic judgments and reasoning mechanisms.

On the face of it, Gigerenzer's strategy is quite persuasive. Nevertheless, we think that it is subject to serious objections. Frequentism itself is a hotly contested view, but even if we grant, for argument's sake, that frequentism is correct, there are still serious grounds for concern. First, as we observed in note 6, there is a serious tension between the claim that subjects don't make errors in reasoning about single events and the ameliorative project that evolutionary psychologists are engaged in. The current point is not that frequentism is false but merely that evolutionary psychologists cannot comfortably maintain both (1) that we don't violate appropriate norms of rationality when reasoning about the probabilities of single events and (2) that reasoning improves when single-event problems are converted into a frequentist format.

A second and perhaps more serious problem with Gigerenzer's use of frequentist considerations is that it is very plausible to maintain that *even if*

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statements about the probabilities of single events really are meaningless and hence do not violate the probability calculus, subjects are still guilty of making *some sort of error* when they deal with problems about single events. For if, as Gigerenzer would have us believe, judgments about the probabilities of single events are meaningless, then surely the correct answer to a (putative) problem about the probability of a single event is not some numerical value or rank ordering but rather: "Huh?" or, "That's utter nonsense!" or, "What on earth are you talking about?" Consider an analogous case, in which you are asked to answer a question like "Is Linda taller than?" or "How much taller than is Linda?" Obviously these questions are nonsense because they are incomplete. In order to answer them you must be told what the other relatum of the "taller than" relation is supposed to be. Unless this is done, answering yes or no or providing a numerical value would surely be normatively inappropriate. Now according to the frequentist, the question "What is the probability that Linda is a bank teller?" is nonsense for much the same reason that "Is Linda taller than?" is. So when subjects answer the single-event probability question by providing a *number* they are doing something that is clearly normatively inappropriate. The normatively appropriate answer is "Huh?," not, "Less than ten percent."

It might be suggested that the answers that subjects provide in experiments that involve single-event probabilities are an artifact of the demand characteristics of the experimental context. Subjects (one might claim) know, if only implicitly, that single-event probabilities are meaningless. But because they are presented with forced choice problems that require a probabilistic judgment, they end up giving silly answers. So one might think that the take-home message is: "Don't blame the subject for giving a silly answer. Blame the experimenter for putting the subject in a silly situation in the first place!" But this proposal is implausible for two reasons. First, as a matter of fact, ordinary people use judgments about single-event probabilities in all sorts of circumstances outside of the psychologist's laboratory. So it is implausible to think that *they* view single-event probabilities as meaningless. But second, even if subjects really did think that single-event probabilities were meaningless, presumably we should expect them to provide more or less random answers and not the sorts of systematic responses that are observed in the psychological literature. Again, consider the comparison with the question "Is Linda taller than?" It would be a truly stunning result if everyone who was pressured to respond said yes.

5. Conclusion

The main aim of this chapter has been to dispel an illusion: the illusion that evolutionary psychology and the heuristics and biases tradition are deeply divided in their assessments of human reasoning. We started by outlining the two research programs and disentangling their core claims from the rhetorical flourishes that have obscured an emerging consensus between the two programs about the scope and limits of human rationality and about the cognitive architecture that supports it. We then showed that, contrary

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to appearances, there is no substantial disagreement between evolutionary psychologists and advocates of the heuristics and biases program over the extent of human rationality. On a number of different readings of what the dispute is supposed to be, *neither research program denies the core claims of the other* and, in many cases, it is clear that they should and do endorse each other's core claims. Finally, we briefly focused on some of the points of disagreement that remain once the illusory dispute has disappeared. Though there are some important issues that divide evolutionary psychologists and advocates of the heuristics and biases program, there is also a surprising degree of consensus. Moreover, and this has been our central theme, they do not really have any deep disagreement over the extent of human rationality.

NOTES

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1. We classify a claim as a *core claim* in one of the two research traditions if (1) it is central to the research program, (2) it is not completely implausible to suppose that the claim is supported by the empirical evidence offered by advocates of the program, and (3) advocates of the program are prepared to endorse it in their more careful moments. *Rhetorical flourishes*, by contrast, are claims that (1) are not central to the research program, (2) are not supported by the evidence offered, and (3) are typically not endorsed by advocates of the program in question when they are being careful and reflective.

2. While Kahneman and Tversky's rhetoric, and Gould's, suggests that untutored people have nothing but normatively defective heuristics or "shoddy software" with which to tackle problems dealing with probability, M. Piattelli-Palmarini goes on to make the even more flamboyant claim that the shoddy software is more likely to get the wrong answer than the right one.

> We are . . . blind not only to the extremes of probability but also to intermediate probabilities—from which one might well adduce that we are blind about probabilities.
>
> I would like to suggest a simple, general, probabilistic law: Any probabilistic intuition by anyone not specifically tutored in probability calculus has a greater than 50 percent chance of being wrong. (1994, pp. 131–132)

This is not, however, a claim that any other proponents of heuristics and biases have been prepared to endorse even in their least careful statements. Nor is there any reason to think that they should, since it is utterly implausible to maintain that this thesis is supported by the available data. We will, therefore, treat Piattelli-Palmarini's "probabilistic law" as a particularly extreme instance of rhetorical excess and ignore it in the remainder of this chapter.

3. The conjunction of the first two central theses of evolutionary psychology constitutes what might be called the *Massive Modularity Hypothesis*. For more

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on this hypothesis, see Samuels (forthcoming) and Samuels, Stich, and Tremoulet (forthcoming).

4. Precisely what it is for a principle of reasoning to be *derived from* the rules of logic, probability theory, and decision theory is far from clear. For as A. Goldman and Harman have both pointed out, rules of rational inference cannot literally be derived from logic and probability theory (Goldman 1986, p. 82; Harman 1986, chapter 2). Nor is it clear which of the rules of logic, probability theory, and decision theory our judgments and reasoning mechanisms must accord with in order to count as rational. Moreover, there are serious disagreements about which *versions* of logic, decision theory, and probability theory the correct principles of rationality ought to be derived from (see, for example, Gigerenzer 1991a). Nonetheless, the essential idea is that we use the rules from these formal theories as a guide in constructing normative principles that can then be employed in order to measure the extent to which human reasoning and judgment is rational.

5. Indeed, evolutionary psychologists take the fact that performance improves in frequentist tasks to *support* the frequentist hypothesis.

6. This also poses a serious problem for Gigerenzer's claim that problems about single-event probabilities are meaningless and that, as a result, subjects' responses to such problems are not violations of the probability calculus. If problems about single events are really meaningless, then subjects' answers to such problems *couldn't* be wrong by the lights of the probability calculus. In which case, it is extremely hard to see how performance on reasoning tasks could *improve* when problems are reformulated in terms of frequencies as opposed to single events. Indeed, if, as evolutionary psychologists often appear to suggest, the frequentist problems given to experimental subjects are supposed to be *reformulations* of single-event problems, then it is hard to see how (accurate) reformulations of the original (meaningless) problems could be anything other than meaningless. In short: it is exceedingly hard to see how it could be the case that both (1) human reasoning improves when problems are reformulated in terms of frequencies and (2) nonfrequentist problems are meaningless.

7. An analogy might help to illuminate the proposal: Consider a standard electronic calculator that is designed to take as inputs mathematical problems that are presented in a standard base-10 notation. We might suppose that such a machine is a well-designed, specialized computational device that reliably solves problems that are presented in the appropriate format—i.e., base-10 Arabic notation. But suppose that we were to use the calculator to solve a problem stated in terms of Roman numerals. Since there simply are no buttons for "X" and "L" and "I" there would be no way for the calculator to deal with the problem (unless, of course, we first translate it into Arabic notation).

8. One might think that the notion of format restriction provides us with at least the outline for an explanation of why we perform poorly on probabilistic problems that are presented in nonfrequentist formats: viz., frequentist mechanisms will be unable to "handle" these problems because they are encoded in the wrong format. But the fact that the normatively unproblematic mechanisms are format-restricted only tells us that problems with the wrong format *won't* be assigned to (or be handled by) them. So they must be handled by some other component of the mind. But that's *all* the notion of format restriction tells us, and that hardly counts as an explanation of why we give the wrong answer. Nor, of course, does it explain why we make the specific sorts of systematic errors that have been documented in the psychological literature. So, for

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example, it clearly does not explain why, for nonfrequentist problems, base rates tend to be neglected rather than overstressed or why human beings tend to exhibit overconfidence rather than, say, underconfidence. The point that needs to be stressed here is that it is implausible to think that these normatively problematic responses are the product of normatively unproblematic, format-restricted mechanisms (both because the responses are normatively problematic and because they are in the wrong format). So there must be further mechanisms that are normatively problematic. And that is just what the heuristics and biases tradition says.

9. Compare to Tooby and Cosmides' own suggestion that the human mind "can be likened to a computer program with millions of lines of code and hundreds or thousands of functionally specialized subroutines" (1992, p. 39).

10. Evolutionary psychologists often use the term *rational* in scare quotes. When they do so, it is clear that they intend to refer to judgments, mechanisms, or procedures that are construed as rational by the lights of the standard picture.

11. There are also interesting questions about the relationship between the accuracy-based criterion and the standard picture, but we do not have the space to discuss them here.

12. So, for example, the human visual system may well be accurate relative to the range of information that it processes in the environments in which we typically live. But as Gigerenzer (1998a) notes, our color vision is singularly *un*-reliable in parking lots illuminated by mercury vapor lamps. And in the "world" of the psychophysicist with its array of exotic visual stimuli, other components of the visual system can be very unreliable indeed.

13. See, for example, Godfrey-Smith 1994, Neander 1991, and Plantinga 1993.

14. This problem was first studied by Tversky and Kahneman (1982), who presented subjects with the following task:

> Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.
>
> Please rank the following statements by their probability, using 1 for the most probable and 8 for the least probable.
>
> (a) Linda is a teacher in elementary school.
> (b) Linda works in a bookstore and takes Yoga classes.
> (c) Linda is active in the feminist movement.
> (d) Linda is a psychiatric social worker.
> (e) Linda is a member of the League of Women Voters.
> (f) Linda is a bank teller.
> (g) Linda is an insurance salesperson.
> (h) Linda is a bank teller and is active in the feminist movement.

In a group of naive subjects with no background in probability and statistics, 89 percent judged that statement (h) was more probable than statement (f). For current purposes, the key point to notice is that subjects are asked to make judgments about a single event—e.g., that Linda is a bank teller—rather than a relative frequency. For this reason, Gigerenzer has insisted, contrary to the claims in the heuristics and biases literature, that ranking (h) as more probable than (f) "is not a violation of probability theory . . . [since] . . . for a frequentist, this problem has nothing to do with probability theory" (1991a, pp. 91–92).

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