

TEACHING PROBABILISTIC REASONING

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Many people answer the Cab Problem incorrectly because they fail to consult the base rate. This finding, among related ones in the widely cited judgment under uncertainty literature, offers important implications for the teaching of critical thinking, as Christine McCarthy makes clear. The literature makes a strong case that human probabilistic reasoning is prone to systematic violation of Bayesian norms, and, importantly, that the processes responsible are often implicit. Failure to consult the base rate is one among a class of typical violations that seem to be highly intuitive responses. McCarthy argues, accordingly, that an explicit knowledge of the norms of probability is necessary to guide everyday probabilistic reasoning. Explicit knowledge of the norms of PR will help us notice and over-ride our intuitive judgments, as well as to help us critically apply norms in problematic contexts. "To take chances intelligently," as she quotes Levinson, "we must know and understand the laws of chance." In considering her approach, two key questions arise.

First, is an explicit knowledge of general principles sufficient in itself to reach the desired instructional goal of coping effectively with everyday problems that require probabilistic reasoning? For example, are there cases where explicit remedies to implicit problems are insufficient? Are critical thinkers sufficiently prepared by just having an explicit knowledge of general principles? We might consider more closely the best remedies, including combinations of remedies, for what appear to be highly intuitive reasoning patterns.¹

I argue that McCarthy's approach would be strengthened if instruction was also recommended that directly targets implicit levels of reasoning, as suggested by Jonathon St. B. Evans, a key writer in the psychology of reasoning.² Evans is conducting research with a Macintosh-based system that provides visual feedback for students' exploration of probability-related problems. He finds that users more easily "develop an intuitive grasp of the effects of their decisions."³ Unfortunately, as Evans also notes, such training is likely to be most effective when people are tested in the same domain in which they were trained. I conclude from his research and related work that a hybrid approach to training probabilistic reasoning is the most defensible alternative. We simply must cover all the bases as best we can. We should train for explicit knowledge of general principles, as McCarthy recommends, but we should also we supplement this component with training that targets implicit levels of reasoning. Training should also provide students with as much experience as possible in various domains of everyday life.

Second, are Bayesian norms the only legitimate principles to base critical thinking instruction upon? Are other rules, heuristics or methods of judgment allowable? If so, how should they figure in programs of critical thinking instruction?

Real-world thinking often involves complexity, uncertainty, ill-structuredness, fast-moving situations, and so on.⁴ Given these kinds of constraints, constraints that are only multiplied by the well-known cognitive limitations humans possess such as limitations on short-term memory (that make it difficult to understand multivariate problems) and selective attention (that create a considerable cost for any attention-demanding decision procedure), I argue that it remains an open question as to when unconsciously applied heuristics and biases may prove to be acceptable shortcuts to the use of laborious norms of probability theory. This is not an uncommon view. Nisbett

and Ross, for example, have made the point that intuitive strategies may sometimes serve us well and cost very little.⁵ I do not want to suggest that we should open the floodgates and say anything goes, but rather that we may have to supplement training in formal rules with informal rules, doing our best to help people make the best of admittedly non-formal methods. We can try to teach people to be the best satisficers they can be, or put in another Simonian way, to make the best of our bounded rationality.

If we adjust our epistemology of probabilistic reasoning to be more in accord with psychological capacities, as well as in accord with typical constraints faced in everyday contexts, we would be committing to some variety of naturalistic epistemology such as Goldman's or Cherniak's.⁶ Criticisms are to be expected for such an approach, but I suggest that the onus is on the critic, given the preponderance of evidence related to bounded rationality and the messiness of everyday decision-making. Of course, there is still much to learn about such topics, and this reminds us that much empirical research on critical thinking remains to be undertaken.

One avenue of future research to pursue is to follow the lead of those in the everyday cognition movement who argue that important advances in theories of perception, comprehension and judgment, including the nature and role of implicit levels of reasoning, will derive from close attention to real-world thinking contexts.⁷ Given a more complete *ecology of critical thinking*, we will be in a stronger position to arrive at a realistic epistemology of critical thinking. Accordingly, we will be in a stronger position to prepare students to think critically in everyday life.

¹ For an introduction to the literature on intuitive levels of reasoning, see Arthur Reber, "Implicit Learning and Tacit Knowledge," *Journal of Experimental Psychology: General*, 118, no. 3 (1989): 219-35. See also K. S. Bowers, G. Regehr, and C. Balthazard, "Intuition in the Context of Discovery," *Cognitive Psychology*, 22 (1990): 72-110. Readers may also wish to review related philosophy of education literature on tacit knowledge. For example, H. S. Broudy, *The Uses of Schooling* (New York: Routledge, 1988).

² Jonathan St. B. T. Evans, *Bias in Human Reasoning: Causes and Consequences* (Hillsdale, New Jersey: LEA, 1989), 118.

³ Evans, 119.

⁴ For a discussion of ill-structured knowledge domains, see R. J. Spiro, W. Vispoel, J. G. Schmitz, A. Samarapungavan and A. E. Boerger, "Knowledge Acquisition for Application: Cognitive Flexibility and Transfer in Complex Content Domains," in *Executive Control Processes in Reading*, eds. B. Britton and S. Glynn (Hillsdale, New Jersey: Erlbaum, 1987), 177-99.

⁵ Richard Nisbett and Lee Ross, *Human Inference: Strategies and Shortcomings of Human Inference* (New York: Prentice-Hall, 1980), 254-56.

⁶ See Alvin Goldman, *Epistemology and Cognition* (Cambridge: MIT, Bradford Books, 1986). See also Christopher Cherniak, *Minimal Rationality* (Cambridge: MIT, Bradford Books, 1986). For some more familiar authors who are allies of a psychologically informed epistemology of critical thinking, see Lee Shulman, "A View from Educational Psychology," *Educational Theory* 31, no. 1 (1981). See also J. Blair and R. Johnson, "The Current State of Informal Logic," *Informal Logic*, 9, no. 2 and 3 (1987).

⁷ For an introduction to this literature, see G. Cohen, *Memory in the Real World*, (Hillsdale, New Jersey: LEA, 1988).