

Expert Intuition Is Not Rational Choice
Review of *Sources of Power* by Gary Klein, 20th Anniversary Edition

Review by Gerd Gigerenzer
Max Planck Institute for Human Development
gigerenzer@mpib-berlin.mpg.de

A book celebrating its 20th anniversary may appear to some as old-fashioned or even obsolete. Indeed, *Sources of Power* offers an account of decision making that is at variance with current research in striking ways: It contains no probabilities, utilities, or equations, but only diagrams, graphs, and plenty of stories. Yet this book is not antiquated. Twenty years after first being published, it still offers future directions from which much of current research could benefit.

For one, whereas the bulk of decision research studies how undergraduates solve toy problems they had never encountered before, Klein studies how professionals solve real-world problems with which they have experience. The experts that populate the book include firefighters, intelligence analysts, pilots, nurses, and physicians. As Klein reports, he and his team have slept in fire stations, ridden in M-1 tanks and Blackhawk helicopters, and observed high-stake decisions in intensive care units. Compare these adventurous sites with the safe environment of the psychological lab.

Second, these experts make high-stake decisions under uncertainty, that is, in ill-defined situations that may change in dramatic and unforeseeable ways. Klein's phrase for these is *natural decision making*. Contrast this "natural" world with the stock-in-trade of decision research, lotteries and gambles, where everything is certain, including the probabilities, and nothing unexpected can ever happen.

Third, to make good decisions under uncertainty, experts rely on a repertoire of abilities, including intuition, mental simulation, aspiration levels, and storytelling. These abilities are experts' "sources of power." Compare this view with those of many psychological textbooks that present intuition and story telling as sources of biases rather than of power. Are the textbooks wrong or is Klein in favor of irrationality?

Natural Decision Making and Rational Choice Theory

To answer this question, let us briefly recall what rational choice theory is. In the words of Savage (1954), known as the father of modern Bayesian decision theory, the theory assumes a *small world* where the exhaustive and mutually exclusive set of all future states of the world and their consequences are known. A lottery is one example, the game of roulette another. In a small world, rational choice amounts to estimating for each possible action the utility and subjective probability of all its consequences, multiplying these, and summing up the products. The resulting value is the subjective expected utility of an action. Finally, the action with the highest subjective expected utility is deemed the rational choice. There are many versions of this basic theory, but that is not the issue here. The important point is that rational choice theory has a restricted domain. Savage emphasized that its usefulness is limited to small worlds and that it would be "ridiculous" to apply it other problems such as chess (because of intractability, that is, the optimal sequence of moves cannot be computed) or planning a picnic (because of uncertainty, that is, one cannot know ahead all consequences that might happen) (Savage, 1954, p. 16).

Experts rarely deal with small worlds. Klein does not refer to Savage, but instead takes Hubert Dreyfus' distinction between what computers and humans can do as a starting point. Yet the limits of rational choice theory can already be found in Savage. These limits are a first step towards appreciating why Klein is looking for entirely different "sources of power."

Savage's limits also clarify that the problem here is not rational choice theory per se but rather the widespread yet mistaken belief that the theory can provide a universal norm for all rational behavior. Klein's second and related target of critique is the heuristics-and-biases program. According to him, "heuristics and biases do not

occur in experienced decision makers working in natural settings” (2018, p. 274). Although this program agrees with Klein that people’s behavior systematically deviates from rational choice theory, it differs with him by nevertheless upholding the theory as a universal norm: If people’s choices differ from rational choice theory, the heuristics-and-biases program attributes this deviation to flaws in the human mind rather than in the theory.

How Relevant Is Consistency?

In rational choice theory, consistency (also called *coherence*) is what matters, not domain knowledge and expertise. Rules of consistency, such as transitivity and Bayes’ rule, define abstract relations between choices or judgments, without considering content or context. Klein argues against the identification of good decision making with consistency, citing Ralph Waldo Emerson’s “A foolish consistency is the hobgoblin of little minds.” Is Klein going too far? After all, much of psychological research interprets violations of consistency as cognitive errors, and some claim that these violations lead to detrimental costs in the real world, such as in terms of health and wealth. Klein is skeptical, arguing that checking consistency quickly becomes computationally intractable. Today, we have the empirical evidence to answer the question of whether inconsistency matters and has costs in the real world. Hal Arkes, Ralph Hertwig, and I analyzed more than one thousand published papers on violations of consistency—including violations of transitivity, the conjunction rule, and Bayes’ rule, as well as preference reversals and framing errors. We found little to no evidence that violations of consistency actually have measurable costly consequences, such as less wealth, health, or happiness (Arkes, Gigerenzer, & Hertwig, 2016). Lack of evidence for costs does not of course mean evidence for lack of costs. However, this striking absence of evidence supports Klein’s doubts about the relevance of consistency rules for expert decision making in an uncertain world.

Klein also levels methodological critique of research that tries to document that people suffer from systematic flaws in reasoning. Again, there is now empirical evidence for several of Klein’s arguments. For instance, Klein (2018, p. 274) criticizes Tversky and Kahneman’s (1973) demonstration that people overestimate the frequency of words where the letter R appears in the first as opposed to in the third position.¹ This overestimation was attributed post hoc to the *availability heuristic* (words beginning with R come to mind faster). Psychological textbooks still present this study as a showcase of systematic cognitive illusions and “availability.” As Klein notes, however, Lopes (1991) pointed out that the five consonants selected for this study, including R, are all atypical because the majority of consonants are actually more frequent in the first position (just as the majority of participants thought). Klein (2018, pp. 274–275) argues that testing participants on selected, uncharacteristic cases in order to demonstrate that they have systematic biases amounts to nothing less than a confirmation bias in research. Meanwhile, we also have an empirical test of this concern. When Tversky and Kahneman’s experiment was repeated with all consonants and vowels—that is, without selecting atypical cases—people’s frequency estimates closely agreed with the actual rank ordering of letter frequencies. Furthermore, when availability was actually measured in terms of the time the first word came to mind or alternatively as the number of words that came to mind within a time frame, none of these versions of availability could actually predict people’s estimates (Sedlmeier, Hertwig, & Gigerenzer, 1998). Thus, Lopes’ suspicion was correct: By using selected, atypical test items, one can always make people appear systematically biased.

A similar point can be made with respect to so-called systematic fallacies in experts. Probably the best-known case is the hot-hand fallacy, the allegedly erroneous and stubborn belief shared by coaches and sports players in the “hot hand,” that is, in the existence of magical moments where a player is “on fire” or “in the zone.” Today we know that the hot hand indeed exists and that the alleged fallacy resulted from an

error in researchers' statistical thinking that was falsely attributed to coaches' intuitions (Miller & Sanjuro, 2018). Meanwhile, quite a few other so-called cognitive illusions have been shown to be due to a "bias bias" in researchers' thinking, namely the tendency to spot biases even when there are none (Gigerenzer, 2018). These examples illustrate that Klein's critical view of demonstrations of systematic biases in the real world of expertise, including sports, is well grounded.

Taking Uncertainty Seriously

Klein defines uncertainty by a list of features, such as high-stake decisions with time pressure where information is unreliable, ambiguous, or missing, and where goals may be ill-defined (2018, p. 280). High-stake decisions are those in which lives are in danger. Ill-defined goals are those where the problem that needs to be solved may be initially unclear. For instance, fireground commanders need to find out whether the goal is to extinguish the fire, or whether the fire is so strong that the goal is to prevent it from spreading further. In the psychological literature, by contrast, the term *uncertainty* is often misleadingly used for *risk* (where you can predict the likelihood of a future outcome), wrongly suggesting that all problems can be solved by logic and probability theory. Once again, statisticians and economists have long since reminded us to take the distinction between situations of risk (such as small worlds) and uncertainty seriously (Knight, 1921).

To his credit, Klein indeed takes uncertainty seriously. Yet decision making under uncertainty requires other tools than decision making under risk. What are these tools that Klein calls *sources of power*?

Natural Decision Making

In Klein's view, experts work not merely with one strategy such as utility maximization or Bayes' rule but with a repertoire of abilities. These include expert intuition, mental simulation, metaphor, and storytelling. Klein provides empirical evidence to support this view, based on observation and interviews. Undoubtedly the most striking observation—from the point of view of anyone trained in rational choice theory—is that experts rarely make choices.

Klein, as he tells us, was never part of the decision research community, nor did he ever take a course on decision making; instead he worked for the Air Force and later founded Klein Associates, a research and developmental company. Anyone who *has* taken a course in decision research, however, is likely to have been told that experienced people carefully compare options, while novices jump on the first one that comes to mind. According to Klein, it's the other way around. He reports that the experts he studies, such as firefighters and emergency room physicians, rarely compare options (2018, p. 24). Rather, based on their experience, a single option comes to mind. An expert may follow it immediately or mentally simulate the option, imagining it being carried out. If this simulation does not lead to the desired goal, then the same process is repeated with the second option that comes to mind, and so forth. Several options may be considered but are not compared; that is, options are evaluated one-by-one until one is found to be good enough. And if the situation changes because, for example, the fire has spread, this process is started again.

As Klein admits, it took him a while until the evidence convinced him that this fundamental assumption of rational choice theory was wrong, and that experience enabled an expert to come up instantly with a good option (2018, p. 17). That was the birth of what he calls the *recognition-primed decision model*.

I compared Klein's account of what firefighter commanders do with that of Klaus Maurer (2018), former head of the Hamburg fire department. Maurer does not cite Klein's work but likewise describes the typical situation as one of uncertainty, time pressure, and limited information. He also does not use any probabilities, utilities, or other rational choice tools. Unlike Klein, he explicitly outlines routines to be prepared for making decisions under time pressure. These begin with extensive training in dealing with stress and learning basic skills and tactical concepts, which

can then be routinely tapped on under time pressure. A second preparatory step occurs daily at the beginning of each shift with an analysis of the “cold situation,” such as the weather conditions, direction of wind, and traffic jams in the city. Once at the site of a fire, he uses heuristic rules for evaluating the “hot situation.” One is the “4A, 1C, 4E” list for analyzing the greatest dangers. This list deliberately includes only nine dangers, so that these can actually be quickly evaluated when time is short. The system’s name refers to the first letters of the German words for the nine dangers: “Atemgifte [noxious fumes], Angstreaktion [fearful reactions], Ausbreitung [spreading], Atomare Gefahren [nuclear threats]; Chemische Stoffe [chemical substances]; Explosion, Erkrankung [illness], Einsturz [collapse], and Elektrizität [electricity].” The commander evaluates which of these dangers is the most pressing, and which needs to be fought against first. To do so, the results of the “cold analysis” are taken into account. All of this needs to be done in seconds, rarely in minutes. The commander then defines the goal but gives the sub-commanders freedom to find a way of meeting this goal, based on their own experience. Feedback and teamwork are essential to this process.

Thus, Maurer and Klein agree about the presence of uncertainty (as opposed to risk) and do not rely on any concepts from rational choice theory. Yet Maurer talks more about the importance of routines and the rote learning of routines, whereas Klein emphasizes the psychological process of pattern recognition and mental simulation. Although their emphases differ, both agree on the role of experience and bounded knowledge and the need to act quickly under time pressure. As Maurer put it, a second-best decision is better than none.

Recognition-Primed Decisions and Fast-and-frugal Heuristics

My own research concerns decision making under uncertainty, with a focus on heuristics (e.g., Gigerenzer, 2015; Gigerenzer, Hertwig, & Pachur, 2011). What are the communalities and differences between the two approaches? And what can each gain from a synergy between both?

Let me briefly characterize the study of fast-and-frugal heuristics. Its first goal, known as the study of the *adaptive toolbox*, is descriptive: to analyze heuristics and their building blocks, which include rules for where to search for information, when to stop search, and how to make a decision. The second goal, known as the study of *ecological rationality*, is prescriptive: to identify the conditions under which a simple heuristic can lead to better outcomes than would more complex strategies. The final goal, known as *intuitive design*, is one of engineering: to determine how to use these insights to design decision aids that people can intuitively understand and how to design environments that support (rather than hinder) people’s intuitions.

The communalities between both programs are evident. Both programs study decision making under uncertainty, not only under risk; both include knowledge and experience in their theories; and both have a more positive view of human intuition and capabilities than has much psychological research with its focus on biases. There have been proposals towards integration (e.g., Bryant, 2002; Keller, Cokely, Katsikopoulos, & Wegwarth, 2010; Shan & Yang, 2017; Todd & Gigerenzer, 2001), which, however, are not mentioned in the 20th anniversary edition. Although all these articles have emphasized the potential of synergy, there has been only limited concrete work to date.

Klein (2015) proposed that the study of fast-and-frugal heuristics would profit from a stronger focus on expertise, which is a point well taken. Meanwhile, we have broadened our research in this direction and developed and tested formal models of heuristic decisions made by experts, including physicians, paramedics, airport customs officers, military personnel, magistrates, and professional burglars (see Gigerenzer, Hertwig, & Pachur, 2011; Katsikopoulos, Şimşek, Buckmann, & Gigerenzer, in press; Keller & Katsikopoulos, 2016; Pachur & Marinello, 2013). One result of this work is that, in comparison with novices, experts tend to search faster for information, stop search earlier, use less information, and rely on simpler heuristics. A second result is

that expertise is important for evaluating which heuristics should be used in which context—that is, the ecological rationality of heuristics.

Whereas Klein (2015) sees his focus on expertise as a valuable asset for the study of fast-and-frugal heuristics, he does not seem to see that his own work could in turn gain from formal models of search, stopping and heuristic decisions—at least he does not entertain this idea. I believe that this is a missed opportunity. The processes described in *Sources of Power* tend to be general, captured by terms such as *recognition*, *pattern matching*, and *mental simulation*, without much further explanation of how they work. In my view, formal models of fast-and-frugal heuristics could make at least some of these processes more precise and thus better understood.

For instance, the recognition-primed decision model assumes that alternatives are not compared but instead considered one-by-one, as mentioned above. If an alternative passes a mental simulation, it is accepted, and search in memory is terminated. In *Sources of Power*, this process is modeled by flow diagrams. However, the process could be investigated at a more concrete level. Recognition-primed decisions resemble a combination of two classes of heuristics: satisficing and lexicographic rules. Both have been able to model experts' search for information, stopping rules, and decision rules. For instance, Berg (2014) studied how 49 Dallas real-estate entrepreneurs decide in which location to invest, and reported that all relied on a satisficing rule: If it is possible to get at least x return within y years, then choose that option. As a result, 82% of the entrepreneurs considered only one, two, or three options before making an investment decision. Like Klein's firefighters, not a single one of these entrepreneurs tried to compare all options and choose the one with the highest expected return, but simply compared each new option with the aspiration level. Yet there is one important difference. In satisficing, the options come in an arbitrary order, whereas for experienced firefighters, the options come to mind in an order based on earlier experience. To model this ordered search, satisficing can be combined with the search process in lexicographic heuristics, where order is a function of previous experience with similar situations. By modeling these processes in more detail, new questions will emerge, such as what cues experts use in order to compare a new situation with those they have previously experienced. This would help to understand the undefined term *pattern matching*, which needs explanation. Studies in checkpoint decisions by military personnel (Keller & Katsikopoulos, 2016) and emergency unit physicians (Gigerenzer, 2015) indicate that just a few cues are typically sufficient and that the processing of these cues can be modeled by fast-and-frugal trees. There is a value in trying to go beyond general concepts, and models of heuristics offer precision that may help in better understanding how experts behave under time pressure. I believe that natural decision making could profit from such a better understanding.

The Bottom Line

As mentioned earlier, on its 20th anniversary, *Sources of Power* continues to offer relevant directions and corrections of current research on decision making. There are several take-home messages. First, current decision research needs to rethink its obsession with people's alleged biases and focus instead on the strength and abilities of experts. Second, expert intuition is generally an asset based on experience rather than something to be frowned upon. Third, spending time in fire stations and intensive care units may actually be informative for researchers—and a cure for those who believe in the universal value of rational choice theory. Finally, there is a larger theoretical task that both naturalistic decision making and fast-and-frugal heuristics have begun to address: to develop a genuine theory for decision making under uncertainty.

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