Rational Intuition

PHILOSOPHICAL ROOTS, SCIENTIFIC INVESTIGATIONS

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Intuition in Strategic Thinking


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Intuition in Kahneman and Tversky’s Psychology of Rationality

THOMAS STURM

A NEW CONCEPT OF INTUITION

There is a concept of intuition peculiar to the 20th century, especially its last decades: the idea that intuitions are fast and automatic cognitions, which have to be explained in terms of – typically though not necessarily subconscious – rules of thumb called “heuristics.” This notion of intuition is widespread in psychological theories of reasoning or judgment and decision making. It is shared by Daniel Kahneman, Amos Tversky, Richard Nisbett, Lee Ross, and other adherents of their “heuristics-and-biases” approach, but also by many of their more or less fervent critics in the so-called “great rationality debate” (Tetlock & Mellers, 2002; cf. Samuels, Stich & Bishop, 2002; Sturm, 2012), such as Robin Hogarth, Keith Stanovich and Richard West, or Gerd Gigerenzer. (This is so notwithstanding important differences among these authors and the psychologists mentioned first, some of which I will have reason to point out.) Some psychologists dealing with rationality blame intuition, whereas others, in increasing numbers, praise it. Still, they mostly agree about core aspects of the concept of intuition. Through semipopular presentations, it has even entered public discourse (e.g., Ariely, 2008; Gigerenzer, 2007a; Kahneman, 2011; Kast, 2007; Myers, 2002).

The concept differs strikingly from older ones (cf. also Osbeck, 1999). For instance, it bears little if any resemblance with the immediate grasp of universal or timeless truths – in other words, axioms of Euclidean geometry or principles of logic – that Aristotle or Descartes viewed as a basic intellectual source of knowledge (see Machamer & Adams, this volume). Nor does it agree with the Kantian notion of a sensible representation of particular objects located in specific space-time regions (different from the concepts of the intellect, but still necessarily related to them; see Robinson, 2014). The creative insights or “eureka” moments that Archimedes, Poincaré, and
many other scientists have spoken about when describing unexpected insights (see Thagard, 2014) are even less related to it. Finally, to pick another current—and controversial—view, the notion of intuition to be discussed here is markedly different from the evidential basis for the sober concept-chopping of current analytic philosophers (see, e.g., Cappelen, 2012; Dennett, 2013; DePaul & Ramsey, 1998; Pust, 2000). All these things have all been described using the term "intuition" or its cognates in other languages (from the Latin intueri = to look at/into, to consider). Also, all these notions assume that intuition involves no conscious inference. Beyond that, however, nothing connects such notions with that of current psychologists dealing with human reasoning. Not all of the other kinds of intuitions typically come about fast, unconsciously, or automatically—they might require close and conscious analyses of meanings, a deliberate use of analogies, thought experiments (as Dennett (1984, 2013) has called them, "intuition pumps"), or imagined counterfactual situations. And none of them is necessarily connected to heuristics. Moreover, while the Aristotelian notion guarantees true insight or knowledge of basic truths, and the others also contribute to knowledge in different but essential ways, the connection between heuristics-based intuitions and knowledge, let alone knowledge of basic truths or first principles, is at best accidental, at worst nonexistent. Kahneman and Tversky's notion of intuition typically refers to the fast retrieval of familiar and quite often, at least according to their favorite standards, false or "illusory" beliefs.

This is a complex and striking conceptual shift. The psychologists to be discussed here could or perhaps should have related their conception to one or another previously established idea. That is not what has happened. Perhaps this should not be worrying. It is often said, and justly so, that clear concepts need not stand at the beginning of research but can be developed alongside ongoing investigations. The latter, however, has not happened either (a partial exception proving the rule: Betsch, 2008). The new concept plays important roles in theories of rationality nonetheless. It seems that most psychologists think that the concept is an innocent one (which it is not), or that they do not have to pay attention to how the concept of intuition is understood or used in other traditions (which may be doubted).

All this suggests several general questions. Where did the new meaning come from? What are the main psychological theories of rationality in which intuition plays a role? Which role? What to think of all this? Of course, these are questions that I cannot answer entirely here. But I shall try to shed some light on them by focusing on Kahneman and Tversky's concept of intuition, unraveling its origins, meaning, and problems. I begin by recounting two important historical backgrounds of current debates, namely Egon Brunswik's metaphor of the perceiving organism as an "intuitive statistician" (Section 1), and its rather unreflective - transfer and expansion into the whole area of judgment and decision making (Section 2). Up until the 1970s, heuristics have not played a role in the concept of intuition. This only came with Kahneman and Tversky's theory of heuristics and biases (Section 3). Finally, I discuss central problems of their account of intuition. Not only does it imply changes from a view such as Brunswik's that have not been sufficiently reflected on; partly due to this neglect, their account also suffers from serious deficiencies in all of its major aspects. This reveals a lack of clear conceptual thinking in Kahneman and Tversky's works (Section 4).

Apart from the significance of these results for the psychology of rationality, there are potential implications for philosophy here that I cannot explore further in this chapter, but that I wish to mention at the outset. George Bealer (1999, p. 31) has maintained that the psychologists' concept of intuition is simply different from current philosophical ideas. My goal, however, is to reveal problems in Kahneman and Tversky's concept of intuition, including their related claim about the unreliability of intuitive judgments. Some philosophers have generally questioned the evidentiary role of intuition because the psychology of heuristics and biases has already shown that intuitive judgments are frequently mistaken (cf. e.g., Thagard, 2012; Weinberg, Nichols, & Stich, 2001). Again others have used accounts of intuition building on Kahneman and Tversky's work for assessing the credibility of philosophical intuitions (e.g., Nagel, 2012). I encourage readers to draw their own conclusions concerning these issues from the following considerations.

1. **PREHISTORY: E贡GON BRUNSWIK AND THE "INTUITIVE STATISTICIAN"**

In the beginning there was uncertainty. Intuition entered the psychology of rationality through the recognition that, contrary to the ideal of an omniscient and cognitively all-powerful reasoner, humans have to grapple with tasks for which they have less than optimal cognitive resources (e.g., limited time, memory, and computational power). We have to draw inferences that are, more often than not, nondeducive, risky, or fundamentally probabilistic. Accordingly, probability theory and statistics are obvious candidates for how we do this. The question is in which sense, with what success, and how intuition enters the picture.
Perhaps, the first psychologist who connected intuition and probability or statistics was Egon Brunswik (1903–1955), who had studied under the eminent German thought psychologist Karl Bühler in Vienna in the 1920s—contemporaneously with Karl Popper. Brunswik also joined Moritz Schlick’s famous circle. He combined ideas of Bühler, Hans Reichenbach, and Karl Pearson’s correlational statistics in his “probabilistic functionalism.” According to Brunswik, the main role of human perception and thinking is to adapt to its environment. Since that environment usually provides numerous different, ambiguous and uncertain cues, human beings have to process information in a probabilistic or statistical manner (Hammond & Stewart, 2001; Leary, 1987). Hence, the mind is an “intuitive statistician” (Brunswik, 1955, p. 212, 1956, p. 80).

The probabilistic nature of Brunswik’s work has been studied intensively. It has been shown which statistics he used (Pearson’s correlational statistics), that he demanded that the subject’s mind and the properties of the environment should be studied in tandem, that the “probabilistic functionalism” constituted a break with his own earlier psychological research, and so on (Gigerenzer & Murray, 1987, pp. 65–81; Leary, 1987). But what has not been clarified is why Brunswik came to call this implicit use of statistics “intuitive.” For instance, why did he not instead speak of “unconscious” or perhaps even “instinctive” statistics? Both options were available at the time. Moreover, both would have made it possible for us to view his conception as a clear precursor of later ideas that take intuition to be a type of judgment and decision caused by unconscious mechanisms or rules.

One might speculate about why Brunswik did not choose those terms. But I won’t engage in this here. It suffices to point to evidence that can explain his choice of “intuitive.” He applies the metaphor of the intuitive statistician primarily in order to explain perception, which he had earlier on explicitly described as “intuitive,” and distinguished sharply from thinking:

In a merely functional sense, therefore, intuitive perception seems to be a somewhat autonomous but more primitive cognitive function (or sub-personality) working in principally the same ‘constructive’ (inductive and – by means of ‘transfer’-mechanisms – also deductive) way as the critical instances of verbalized measurement and computation do. The difference seems to be merely one of degree. As also has been shown by experiment, the perceptual system is – as compared, in a functional sense, with discursive methods of knowledge – relatively inertial, stereotyped, superficial, confused, unanalytical, and sometimes narrow in its admission of and its ways of evaluating cues. (Brunswik, 2003a, p. 50)

Although Brunswik claimed that intuitive perception and thinking operate by similar probabilistic rules, he nonetheless viewed them as different cognitive functions. Since he viewed perception as “somewhat autonomous,” “relatively inertial, stereotyped, superficial, unanalytical,” and so on, thinking or “discursive methods of knowledge” must accordingly be less autonomous (presumably, that means dependent on the input of other mental functions), faster and more flexible, analytical, and so on. While Brunswik claimed that the distinction is one of degree, presumably there are also clear cases at each end of the spectrum. Later works show that he kept to the distinction (e.g., Brunswik, 2001 b, pp. 78 and 103, fn. 15; 1956, p. 89). Of course, there can be unclear cases in the middle of the spectrum, and surely one might accept that thinking and perception can be related to one another. None of this is excluded by his distinction. What matters here is that “intuitive” in Brunswik’s talk of the “intuitive statistician” does not so much characterize the statistics as being sub- or unconscious (although this is not excluded), but refers to the domain that statistics is applied to – perception.

Three further aspects of Brunswik’s work support this reading. First, he argued that one can prove the difference between the two functions empirically by showing the distinct distribution of errors associated with each of them. While the errors in perception followed a normal distribution, errors in thinking showed a truncated distribution with outliers (Brunswik, 2001 b, p. 103, fn. 15; 1956, pp. 89–93). Second, Brunswik spoke of a “quasi-rationality” of perception: it resembles a kind of rational thinking, namely the use of correlational statistics (Brunswik, 1952, p. 24). While perception can be described as literally embodying the statistical technique, this does not change the nature of perception as being autonomous, relatively inertial, unanalytical, and so on. Third, while Brunswik used statistics in order to study certain judgments, namely of frequencies, he did not apply the term “intuitive” to them or other processes of thinking. These points, to which others could be added, reveal that he accepted a clear distinction between perception and thinking, intuition and intellect and, moreover, that the “intuitive statistician” might also have been called the “perceptual statistician.”

2. FROM INTUITIVE STATISTICS TO STATISTICAL INTUITIONS: JUDGMENT AND DECISION MAKING

Since the latter half of the 1950s, Brunswik’s metaphor has become more widely used. However, while he had studied the “intuitive statistician,” most later psychological debates revolved around “statistical intuitions,” understood as kinds of judgments and decisions – their existence, their subconscious
causes, and their validity. Thus, the domain of the cognitive psychologist's term "intuition" became broadened, creating anew the study of human reasoning. This can be shown by means of a useful survey of experimental studies published in 1967 by Cameron Peterson and Lee Roy Beach, which even carried the metaphor in its very title. Indicating that Brunswik's main concern had been to explain how the mind achieves veridical perception of its uncertain environment, they extended the metaphor of the intuitive statistician without any justification into the whole area of judgment and decision making under uncertainty.

This review considers experimental research that has used probability theory and statistics as a framework within which to study human statistical inference. ... Marx's problems with his uncertain environment are similar to those faced by social enterprises such as science, industry, and agriculture. ... The psychological research consists of examining the relation between inferences made by man and corresponding optimal inferences as would be made by "statistical man."

(Peterson & Beach, 1967, p. 29)

The review on "predecisional processes of intuitive statistics" followed the structure of introductory statistics textbooks (Peterson & Beach, 1967, p. 30), focusing on three main topics: (i) judgments concerning the description of samples of data, or "intuitive descriptive statistics"; (ii) "intuitive inferential statistics" or the drawing of conclusions about populations on the basis of samples; (iii) finally, "intuitive predictions." For instance, under (i) they reported on psychological studies of judgments of proportions, means, and variances, under (ii) on results concerning inferences about population parameters and proportions, the consistency of inferences, and the drawing of sample sizes. One might object that it is strange if not unfair to present more or less untutored subjects with tasks that require statistical training, but John Q. Public did pretty well. In a nutshell, Peterson and Beach (1967, p. 42) concluded that "the normative model provides a good first approximation for a psychological theory of inference." Would they have told us that we could save money because our offspring do not need to take statistics classes, given that their minds work just fine? No: Peterson and Beach did not overlook some discrepancies between normative theory and actual behavior. But, as we shall see in the next section, others went much further. However, a consequence of the results reported by Peterson and Beach is that no special model for explaining these judgments is needed. As before in Brunswik, statistical models could be used to account empirically for human cognition under uncertainty.

Intuition in Kahneman and Tversky's Psychology of Rationality

3. KAHNEMAN AND TVERSKY: INTUITIONS AS BASED ON HEURISTICS RATHER THAN STATISTICS

It was especially Daniel Kahneman and Amos Tversky who attacked this consensus. They (Kahneman & Tversky, 1972, pp. 445, 449) charged Peterson and Beach and the studies they based their survey on with being overly optimistic. As Kahneman and Tversky claimed, humans typically do not judge or decide in ways that are in accord with what formal logic, probability theory, and statistics, or the theory of rational choice require. Instead, they use certain "heuristics" — simple rules of thumb that can sometimes (or often) lead to valid judgments and decisions, but sometimes (or often) also lead to mistakes called "fallacies," "biases," or "cognitive illusions." At least during the 1970s, Kahneman and Tversky's work enjoyed something close to general acceptance within psychology (e.g., Nisbett & Ross, 1980). It has also become widely influential both inside and outside of psychology, for instance in philosophy (e.g., Bishop & Trout, 2005; Goldman, 1986; Stich, 1985, 1990; Stich & Nisbett, 1980), political science (Erickson et al., 2013, ch. 6), and of course in economics — leading up to the Nobel Prize for economics awarded to Kahneman in 2002. All that is familiar ground. However, their concept of intuition has rarely been scrutinized, despite the fact that it is all over the place in their works.

Just consider the bias Kahneman and Tversky have called the "law of small numbers" — the tendency to draw conclusions from very small samples rather than heeding the rule that only large samples will be representative of the population from which they are drawn:

Our thesis is that people have strong intuitions about random sampling; that these intuitions are wrong in fundamental respects; that these intuitions are shared by naïve subjects and by trained scientists; and that they are applied with unfortunate consequences in the course of scientific inquiry. ... The true believer in the law of small numbers commits his multitude of sins against the logic of statistical inference in good faith. ... His intuitive expectations are governed by a consistent misperception of the world. (Tversky & Kahneman, 1971, pp. 105, 110)

And, more generally

The ... prevalence of biases are not restricted to laymen. Experienced researchers are also prone to the same biases when they think intuitively. ... Although the statistically sophisticated avoid elementary errors, such as the gambler's fallacy, their intuitive judgments
different classes of entities forces different connotations of “intuitive.” Only in the first reference class do we learn a bit about this: intuitive judgments are reached “by an informal and unstructured mode of reasoning, without the use of analytic methods or deliberate calculation” – this obviously being a hint at heuristics. It is not entirely clear whether the sense of “intuitive” as applied to judgments is the same as the one presupposed in the second and third classes. But perhaps it is reasonable to assume that it is: after all, is the “lay model of the world” not reached “by an informal and unstructured mode of reasoning,” characteristic of how intuitive judgments come about? And does our “normal conduct” come about by anything else but such a mode of reasoning? It would thus seem that the sense of “intuition” in the latter two cases would come down to the first one. Kahneman and Tversky should surely have welcomed this, since this understanding would fit with their claim of the importance of heuristics. So we should concentrate on the first meaning, which is clearly prevalent for their approach anyhow (although, as we shall later learn, they are not entirely consistent here).

The following points can be extracted from their work:

1. Kahneman and Tversky applied the terminology to judgments, inferences, and decisions. For sake of simplicity, I shall in what follows only consider judgments, although the cases of intuitive inferences and decisions might deserve a treatment too. The judgments in which Kahneman and Tversky are primarily interested are judgments under uncertainty, that is, judgments involving probability or statistics. Yet, this is not a defining part of their concept of intuition. In their view, tasks in logical or deductive reasoning such as the Wason selection task (Wason, 1966) can also be used to elicit intuitive judgments (Kahneman & Tversky, 1982a, p. 128).

2. By calling judgments “intuitive,” Kahneman and Tversky explicitly likened them to perceptions. Thus, their concept in a sense connects back to Brunswik’s, but at the same time they also downplay if not disregard the latter’s sharp distinction between perception and thinking. Kahneman and Tversky made this move for various reasons. One is that they focused on judgments that come to a person’s mind quickly, without much or any deliberation and consideration (Kahneman, 2011, p. 6). But more important than this is the following. Just as there exist illusions of perception, such as distortions of size, shape, or distance in vision, and just as these cannot be overcome by insight into their illusory nature, so, they claimed, there exist severe, systematic, and ineradicable “cognitive illusions.” Just as in distance perception “the reliance on clarity as an indication of distance leads to common biases,” so such “biases are also found in the intuitive judgment of probability” (Kahneman & Tversky, 1977, pp. 1, 2; Tversky & Kahneman,

are liable to similar fallacies in more intricate and less transparent problems.
(Tversky & Kahneman, 1974, p. 1130)

People have erroneous intuitions about the laws of chance.
(Tversky & Kahneman, 1971, p. 105)

To begin, note a certain ambiguity here. In the last statement, the claim apparently is that people have “erroneous intuitions,” which is compatible with them also having correct or true intuitions, and perhaps many. However, in the other statements, Kahneman and Tversky tend toward the stronger claim that intuitions as such are erroneous, or at least typically cause errors or biases. Thus, “when” researchers “think intuitively,” they are “prone to the same biases” as laypersons; and the “intuitive expectations” of the believer in the law of small numbers “are governed by a consistent misconception of the world.” Which of these two options prevails in Kahneman and Tversky’s studies on heuristics and biases?

An answer to this question is not easy, partly because they never really explained their concept of intuition. Only in one article, perhaps in reaction to a debate with the philosopher L. J. Cohen (see below), they provided what they call “three different senses” of “intuitive”:

First, a judgment is called intuitive if it is reached by an informal and unstructured mode of reasoning, without the use of analytic methods or deliberate calculation. For example, most psychologists follow an intuitive procedure in deciding the size of their samples but adopt analytic procedures to test the statistical significance of their results. Second, a formal rule or a fact of nature is called intuitive if it is compatible with our lay model of the world. Thus, it is intuitively obvious that the probability of winning a lottery prize decreases with the number of tickets, but it is counter-intuitive that there is a better chance that a group of 23 people will include a pair of individuals with the same birthday. Third, a rule or a procedure is said to be part of our repertoire of intuitions when we apply the rule or follow the procedure in our normal conduct. The rules of grammar, for example, are part of the intuitions of a native speaker, and some (although not all) of the rules of plane geometry are incorporated into our spatial reasoning.

(Kahneman & Tversky, 1982a, p. 124f.)

This is not so much an explanation of the sense (or connotation) of the term “intuitive” but, rather, a declaration of the different objects this expression refers to (its denotation): “judgments,” “formal rules or facts of nature,” and “rules or procedures” that we follow in “our normal conduct.” It is barely stated whether the application of the terminology to these

Consider the so-called “illusion of validity” – a predictive bias due to selecting an outcome representative of the input, without regard for factors that limit predictive accuracy. This was actually the first illusion Kahneman identified. Early on in his career, he had been assessing candidates for officer training in the Israeli army. Subjects were asked to perform stressful tasks without wearing any signs of their rank. The experimenters had to assess leadership quality in terms of ratings of candidate’s potentials, and were quite convinced of these predictions. On “statistics day,” however, the psychologists got feedback from the officer training school, and it turned out that the assessments did not match with the feedback. In other words, the psychologists could not reliably predict “who would be a good leader and who would not” (Kahneman, 2002; cf. Erickson et al., 2013, ch. 6). They had uncritically assumed that there was a strong enough correlation between performances in particular experiments and the skill of leadership. There are also other examples of the “illusion of validity,” such as selection interviews. The important point here is that Kahneman and Tversky claim that this is not a mere error, which could be corrected, but an illusion: it “persists even when the judge is aware of the factors that limit the accuracy of his predictions” (Tversky & Kahneman, 1974, p. 1126; cf. Tversky & Kahneman, 1983, p. 313).

The same allegedly holds for the long list of further illusions, biases, or fallacies, such as the “gambler’s fallacy,” “conjunction fallacy,” “overconfidence bias,” “hindsight bias,” and the “illusion of control,” to mention but a few (Gilovich, Griffin, & Kahneman, 2003; Kahneman, Slovic, & Tversky, 1982; Nisbett & Ross, 1980; Sutherland, 1992; Tversky & Kahneman, 1974, 1983). As friendly commentators of their work have written:

Kahneman and Tversky had a flair for conjuring up cases in which intuitive powers of reasoning diverge from formal standards of rationality that, on reflection, most of us say we embrace.

(Tedlock & Mellors, 2002, p. 94)

How bad are things? Should we conclude that we can save money, though now for the opposite reason: namely, our offspring should not take classes in probability theory and statistics, since they cannot improve their shabby reasoning abilities anyway? As we will see, Kahneman and Tversky actually recommended the opposite: we need to spend more money.

Now, Kahneman and Tversky have tried to downplay what appears to be an overly pessimistic view of human rationality contained in their work by claiming that they focused on biases or illusions for primarily if not exclusively methodological reasons. Just as in perceptual theory, in order to figure out how the mind works, it is useful to look at what occurs when things go wrong. Addressing critical discussions of their work, Kahneman and Tversky remarked that “although errors of judgments are but a method by which some cognitive processes are studied, the method has become a significant part of the message” (Kahneman & Tversky, 1982a, p. 124; cf. Kahneman & Tversky, 1996, p. 582). However, this is misleading as far as it suggests that the mentioning of biases or illusions is merely an expression of a method. It is not. Clearly, Kahneman and Tversky did not maintain that all intuitive judgments are illusory or fallacious. Sometimes they even said that intuitive judgments are often correct or at least “useful” and only “sometimes . . . lead to severe and systematic errors” (Tversky & Kahneman, 1974, p. 1124). But several of the above quotations, to which many others from their work could be added, make it clear that they maintain that quite a lot are illusory or fallacious.

3. Nonetheless, the methodological issue just mentioned brings us directly to another core feature of Kahneman and Tversky’s concept, namely the new explanation of intuitive judgments of probability or statistical intuitions. Intuitive judgments, inferences, and decisions are due to underlying cognitive rules of thumb called “heuristics,” which are said to operate subconsciously, at least typically. By studying biases, Kahneman and Tversky said they found several general-purpose heuristics – most notably, availability, representativeness, and anchoring and adjustment (Tversky & Kahneman, 1974), but also others (e.g., the “simulation heuristic,” Kahneman & Tversky, 1982b). For instance, when subjects judge that it is more probable that Linda is a feminist bank teller than that she is a bank teller (thus ignoring the conjunction rule of probability; Tversky & Kahneman, 1983), or that Steve is more likely to be a librarian than a farmer (thereby neglecting prior probabilities; Tversky & Kahneman, 1974, p. 1124) this allegedly is so because of the representativeness of the descriptions of Linda and Steve. Again, because of representativeness effects, humans are said to be insensitive to sample size. Likewise, when people think that there are more words in the English language beginning with the letter “r” than words having the same letter in the third position, or when they think that politicians are more prone to adultery or corruption than other humans, that is so because the availability heuristic is operating in their minds. Consider the list rabbit, road, rubbish, . . . and the list car, furniture, boring . . . how long do you need until you have added five more items to the first list? How long for the second list? Also, we have read more reports about the personal lives and
misteps of politicians than about many other social groups (Kahneman, 2011; Tversky & Kahneman, 1974, 1983). When reasoning problems achieve a certain level of intractability, due to their complexity, time pressures, and so on, we resort to heuristics.

A related and important point is the following. One might think that heuristics explain not just any judgments, but only judgments made under uncertainty, more specifically, intuitive judgments made under uncertainty, and even more specifically, only biased or illusory ones. That is not Kahneman and Tversky’s view, however, at least not their original view. Heuristics “produce both valid and invalid judgments” (Kahneman & Tversky, 1996, p. 582). According to this view, there is a symmetry in the explanation of all judgments under uncertainty whatsoever: the same causes, namely heuristic-based processes, bring about both true and false, biased as well as unbiased judgments. This, of course, reflects the point that the focus on biases is necessary in order to investigate what cognitive processes underlie all of our judgments under uncertainty. At the same time, the point must not be overstated: Kahneman and Tversky clearly emphasized invalid judgments, and frequently declared in no uncertain terms that both laypersons and experts are all too often prey to the misleading forces of heuristics.

So much for four core aspects of their concept of intuition: Intuitions are (1) judgments (or also decisions and inferences) that are (2) perception-like and (3) caused by heuristics. While this definition looks rather simple, I have tried to show that it is not purely stipulative. It is closely connected to methodological as well as theoretical assumptions and in part builds on empirical claims.9 This certainly strengthens the concept. Nonetheless, there are critical problems with this notion, to which I turn next.

4. OBJECTIONS TO KAHNEMAN AND TVERSKY’S CONCEPT OF INTUITION

It is by now well known that there are serious objections to Kahneman and Tversky’s whole approach. Beginning around 1980, the debate over it has become quite complex, involving substantial issues such as: What norms may we employ in experiments on human reasoning? What questions should we ask test subjects? Is it true that we do not, even cannot, use statistics to make intuitive judgments? What should an explanation of intuitions in terms of heuristics come down to? (see, e.g., Cohen, 1979, 1981; Cosmides & Tooby, 1996; Gigerenzer, 1991, 1996; Lopes, 1991, 1992; Stanovich, 1999, 2010; Stein, 1996). In the course of the debates, the psychology of rationality has become deeply fragmented (e.g., Evans, 1991; Jungfermann, 1983; Samuels, Stich & Bishop, 2002; Sturm, 2012). Of course, here I focus entirely on the concept of intuition. I shall structure the discussion systematically, from more simple to more thorny objections. They concern several aspects of Kahneman and Tversky’s account: the likening of intuitive judgments to perception, the heuristic basis of such judgments, and even the very consistency of the account.

1. First, a merely apparent inconsistency. Kahneman and Tversky’s doctrine is that intuitive judgments are implastic. Just as in certain circumstances intuitive perceptions cannot be avoided, neither can intuitive judgments; just as we cannot overcome perceptual illusions, so we cannot overcome cognitive illusions either. However, sometimes Kahneman and Tversky also seem to accept that intuitive judgments can be corrected or improved – even though that may be hard. Thus, concerning tasks that would involve an analysis of regression, while there is a “persistence of nonregressive intuitions despite considerable exposure to statistics” they also say that “statistical training alone does not change fundamental intuitions about uncertainty” (Kahneman & Tversky, 1973, pp. 250f). In another context, we read:

Incentives do not operate by magic. They work by focusing attention and by prolonging deliberation. Consequently they are more likely to prevent errors that arise from insufficient attention and effort than errors that arise from misperception or faulty intuition.

(Tversky & Kahneman, 1986, p. 527f)

And the very study of heuristics and biases is supposed to help improving reasoning.

A better understanding of these heuristics and of the biases to which they lead could improve judgments and decisions in situations of uncertainty.

(Tversky & Kahneman, 1974, p. 1131)

All this implies that intuitive judgments can be changed, though it may be difficult and may involve more than training in the probability calculus and statistics. And that seems inconsistent with their official doctrine. But Kahneman and Tversky can solve this apparent inconsistency. Consider again perceptual illusions. While we cannot overcome these illusions, we can nevertheless become aware of them and perhaps even of their causes, and then take measures against taking the illusions naively for granted. We cannot avoid the impression that the horizon moon looks larger than the zenith moon; but we don’t judge that it shrinks while traveling upwards.
Other perceptual illusions are more difficult to detect, and yet if we do detect them, we learn to make the right empirical knowledge claims. Similarly, with intuitive judgments, insofar as we come to know that they are biased or fallacious: "Even if the bias cannot be unlearned, students can learn to recognize its existence and take the necessary precautions" (Tversky & Kahneman, 1971, p. 110). In short, we can make judgments about whether an intuitive judgment is illusory or not. Our more serious knowledge claims will then reflect how we think things really are. Accordingly, the heuristics-and-biases literature contains studies on tools of debiasing (e.g., Kahneman & Tversky, 1977; part VIII in Kahneman, Slovic & Tversky, 1982). That is why I said that Kahneman and Tversky inspired us to write larger checks for the education of our offspring. They need to take courses in logic and statistics, but moreover in heuristics and biases as well.

2. So Kahneman and Tversky claimed that there could be corrective measures, but that "cognitive illusions" as such would persist. But are our first-order intuitive judgments truly so ineluctable? Is intuitive judgment perception-like? One might point here back to Brunswik's sharp distinction between perception and judgment, or to Jerry Fodor's (1983) familiar views that restrict ineluctability to perception and maintain the plasticity of "central cognition" – judgments, decisions, and inferences guided by proper domain-general rules. However, Kahneman and Tversky might plausibly object that this is an empirical affair; we should not simply stipulate or assume from the outset that all judgments are plastic or cognitively penetrable. Moreover, pointing back to Fodor might be conceding too much. Given the reading of Kahneman and Tversky just presented, their claim is not that all judgments are ineluctable. Some are. (One might object to the word "some" here, since they maintained that intuitive judgments are quite widespread. But in the present context that's irrelevant.) And Kahneman and Tversky might be seen as having shown, empirically, which judgments are ineluctable.

But there are objections to that restricted claim too. To open our minds, it may be helpful to consider first a famous historical precursor. Kant viewed the well-known "illusions of reason" – the "dogmatic" beliefs that the Universe must have an absolute beginning in time, that there exists a creator of the Universe, that the soul is immaterial, and so on – in exactly this way. The "Critique of Pure Reason" is supposed to reveal that these beliefs are illusions, to explain by what cognitive mechanisms they arise (briefly put, according to Kant they do so because it is in the nature of reason to draw inferences beyond the limits of possible experience), and how to discipline reason such that we can distinguish the knowable from the unknowable (cf. Kant, 1781/1787, pp. Avii-viii and A296–298/B353–355).

Now, like Kahneman and Tversky, Kant also likened illusions of reason to those of perception. But was he right about, say, the unavoidability of the dogmatic belief in God's existence or in the immateriality of the soul? There are people who do have these beliefs, of course, and who assert that they are unavoidable for finite beings like us. But that can hardly count as good evidence for the unavoidability and implausibility of these illusionary beliefs. As is well known, there are people who do not feel the urge to have those beliefs; who do not automatically have them, not even when presented with, say, the ontological proof of God's existence or perhaps some "intuition pump" (Dennett, 1984, 2013) in favor of mind-body dualism. Moreover, even if one feels forced to accept the belief in the existence of God when given a very plausible argument, one might view such an intuitive judgment as error rather than as an unavoidable illusion. The important point is that if on a second-order level a first-order illusion is detected, it does not disappear. An error can, and often does disappear. And there are good fallibilistic reasons to think that, in philosophy just as well as in science and everyday life, where uncertainty reigns, our judgments are all open to revision, and therefore hardly unavoidable or ineluctable.

Of course, these considerations are mere door openers. To go through the door, we need empirical arguments showing that Kahneman and Tversky's intuitive biases are not really illogical after all. With respect to probability judgments, this has been achieved especially by Gigerenzer and his collaborators. Take conjunctions fallacies or the so-called "Linda problem." The conjunction rule of probability theory states that an event A can never be less probable than a conjunction of the (independent) events A and B: Prob(A) ≥ Prob(A & B). The Linda problem, in a simplified form, then goes as follows:

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, social justice, and also participated in antinuclear demonstrations.

Which statement is more probable?
1. (T) Linda is a bank teller.
2. (T&F) Linda is a bank teller and active in the feminist movement.

Tversky and Kahneman (1983, p. 299) have argued that about 85% of all subjects chose the answer "T&F" and thus violated the conjunction rule. They have moreover claimed the "reality of the illusion": the results in the Linda problem are allegedly stable, and reveal a stubborn and systematic incompetence in human reasoners (Tversky & Kahneman, 1983, 1996).
However, the alleged fallacies are avoidable. One way to show that they are is by representing the task in more transparent ways—for instance, in terms of a frequentist (rather than a subjective) interpretation of probability. This improves performances dramatically, even for statistically untrained subjects. Take the following task:

(Paragraph continues as before)

There are 100 people who fit the description above. How many of them are (a) bank tellers, (b) bank tellers and active feminists?

In the answers to this format, conjunction fallacies dropped from about 85% to 20% and less (Hertwig & Gigerenzer, 1999). Similar impressive results were achieved by using frequency formats in overconfidence tests or in Bayesian tasks, to the effect that subjects no longer overestimate the validity of their answers or neglect the relevance of base rates (Gigerenzer, 1991; Gigerenzer & Hoffrage, 1995). Concerning judgments about sample size, the evidence is at least mixed: sometimes people— even including children from age 11 or 12 onwards!— attend to the law of large numbers, sometimes they do not (cf. Peterson & Beach, 1967; Sedlmeier & Gigerenzer, 1997). Another relevant point that one can observe in teaching the Linda problem is that subjects often get the answer right when the description of Linda is eliminated; the same with the description of Steve (the librarian or farmer). After all, to figure out the right solutions to the task, these descriptions are unnecessary and even misleading. Also, Charness, Karni, and Levin (2010) presented the task in just the way Kahneman and Tversky (1983) had done. Charness et al. (2010) could not replicate the 85%, but found that only 58% of their research subjects committed the fallacy. What is more, when subjects were offered some incentives (e.g., money) in case they got the answers right, fallacies dropped to 33%.

Thus, it is not always the case that by learning about heuristics people will learn to realize that a first-order intuition is illusory, and then form a second-order, critical judgment that this is so. Rather, they can revise their first-order, allegedly implausible judgment. Kahneman (1981, p. 340) claims that he himself continues to fall prey to the gambler’s fallacy. But when one has truly and firmly grasped the roles of unbiasedness and independence of chance setups, my impression is that the “illusion” can disappear. The same with many other alleged illusions.

One might object that things do not always work so easily, that some statistical errors are widespread, or that in different cases we need different tools. Also, is it not the case that we sometimes make fast or “snap” judgments when faced with some reasoning tasks, and are judgments not perception-like in this sense? All this can be granted; all this is also irrelevant for the issue at stake. Kahneman and Tversky’s claim that numerous if not all judgments under uncertainty are intuitive, implastic, or unavoidable, is not well reflected on/argued and, moreover, in a number of cases plainly mistaken. One might stick to Brunswik’s view that, by and large, only perception is truly intuitive, or else give up the idea that intuitiveness implies implasticity. But then it might also be better to look for a different term to describe the idea that some judgments come about quickly, or without much (explicit) deliberation. So much for this part of Kahneman and Tversky’s concept of intuitive judgments.

3. What about the claim that intuitive judgments are brought about by (typically subconscious) heuristics? There are various difficulties with this assumption too. I begin with the symmetry claim: both valid and invalid judgments are caused by heuristics; even when people get things right concerning uncertain or intractably complex matters, this is normally due to the use of heuristics. There is just one system for all kinds of judgments. One obvious problem with this is that even Kahneman and Tversky admit that people sometimes not only judge correctly—in agreement, say, with norms required by the standard picture of rationality (logic, probability theory, and so forth) — but do so because they actually use those very norms. Of course, this may happen only rarely. As Bertrand Russell remarked concerning the “difficult and elusive” matters of philosophical logic, the “really good philosopher is the one who does once in 6 months think about it for a minute. Bad philosophers never do” (Russell, 1910, p. 11). But quantity does not really matter here. What matters is that sometimes judgments are formed because people do think logically or probabilistically.

Kahneman has meanwhile refined this claim to do justice to this objection. Since the early 2000s, he has explicitly accepted views according to which there are two different “systems” or, more cautiously, “processes” of judgment and decision making (Kahneman, 2011, p. 20; Kahneman & Frederick, 2002, pp. 50–52; cf. Evans, 2003; Stanovich, 1999, esp. p. 145; Stanovich & West, 2000). He draws the distinction in at least two basic ways. First, what distinguishes intuitive from deliberate judgments is that while the former involve no attention, effort, or voluntary control, the latter do (Kahneman, 2011, p. 206). Second, while “System 1” follows heuristics and leads to “intuitive” judgments, which are often biased or illusory, “System 2” follows logic and probability theory and leads to “deliberate” judgments which tend to conform to standard rules of rationality. SYSTEM 2, of course, is supposed to correct judgments based on the cognitive illusions to which System 1 is prone (Kahneman & Frederick, 2002, p. 52).
Now, the difference between intuitive and deliberate judgment is, as Kahneman freely admits, a fluid one. There have to be unclear cases, both because we sometimes cannot decide on which side of the spectrum some cases belong, and because often the boundary is in fact permeable. As Alfred North Whitehead pointed out long ago:

It is a profoundly erroneous truism, repeated by all copy-books and by eminent people when they are making speeches, that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of important operations which we can perform without thinking about them. Operations of thought are like cavalry charges in a battle—they are strictly limited in number, they require fresh horses, and must only be made at decisive moments.

(Whitehead, 1911, p. 61)

That is as it should be. (This passage becomes cited more often nowadays. But another citation cannot hurt, if one considers some philosophical discussions about, say, privileged self-knowledge or consciousness.) But why accept Kahneman’s (and many others’) claim that System 1 is guided by heuristics instead of formal rules? Concerning inductive inference, various studies have argued that human infants and even great apes are “intuitive statisticians” (cf. Rakoczy et al., 2014): Bonobos, chimpanzees, gorillas, and orangutans seem actually to track statistical information (e.g., regarding the relative frequency distribution in populations) and are thus able to draw inferences from populations to randomly drawn samples. Similarly, perhaps some fast, intuitive judgments are actually guided by, and not simply in conformity with, certain logical rules (the law of noncontradiction, the rule of modus ponens, and so on). What (good) philosophical teachers in logic do to help students with difficulties concerning, say, arguments involving several negations or multiple quantification is not to give them trick questions but to repeat the task with different contents of the premises, avoid abstract materials, explain the rule carefully, and so on. If instruction goes well, students begin to follow formal rules more habitually and may after a while even find it difficult to state them explicitly, but can invest attention and effort to other issues, just as Whitehead suggested. In philosophy, nothing ought to be changed about Logic 101 coming first. Likewise, to pick up the “conjunction fallacy” once again, a few repetitions of the task in different formats, with and without the description of Linda, with and without incentives, should suffice to help subjects to internalize the rule firmly, and to learn to make relevant judgments in an increasingly fast, intuitive way. If not, consider hiring another instructor.

One might think that Kahneman should have no problems with this. He allows for a kind of intuitive “expert judgment,” pointing to cases such as: chess players who can grasp a complex situation in the game at a glance, although it takes years to acquire that level of expertise; commanders of firefighting teams, who demand that a room has to be left just before the roof below them collapses (the commanders are somehow aware that the fire is unusually quiet and their ears are unusually hot); or medical professionals who unconsciously register subtle signs of a heart attack coming before it hits and call for an ambulance (Kahneman, 2011, pp. 12 and 234–245). As he writes,

Valid intuitions develop when experts have learned to recognize familiar elements in a new situation and to act in a manner that is appropriate to it. Good intuitive judgments come to mind with the same immediacy as “doggie!”

(Kahneman, 2011, p. 12)

Note how Kahneman explains expert intuition, and what he thinks about when “System 2” comes into play. The explanation refers to recognition of patterns stored in long-term memory. Citing Herbert Simon, Kahneman (2011, p. 237) even says that expert intuition “is nothing more than and nothing less than recognition.” So, it is merely the shabby intuitive judgments of laypersons about uncertain matters where heuristics come into play. Expert intuition, in contrast, builds on prolonged experience that has become implicit knowledge and that can be retrieved quickly given the right cue. However, what Kahneman still ignores is that formal rules might explain some intuitive judgments. Judgments based on such rules must, according to (his) dual-system theory, always be effortful, slow, and all that and hence cannot be intuitive. That is just a dogma. This objection is not merely speculative. There are studies showing that people often do conform to rules of logic and probability theory, if more simple ones (e.g., Rips & Marquis, 1977; Goldman 1986, chs. 13–14).15

There are further worries about the explanation of intuitive (lay) judgment in terms of heuristics. For instance, why assume that heuristics only underlie intuitive judgments? Things look different if one adopts a view on heuristics like Gigerenzer’s, according to whom heuristics do not typically lead into fallacies and illusions, but can sometimes perform as well as, or even better than, computationally more costly optimization strategies (Gigerenzer et al., 1999; Gigerenzer, 2007b). Rather than viewing heuristics as lazy shortcuts, one might view them as recommendable, if within limits and given an explanation of why they succeed when they do (Gigerenzer & Sturm, 2012). For the present discussion, the important point is that heuristics, rather than unconsciously underlying only
intuitive judgments, can be, and often are, used deliberately (Kruglanski & Gigerenzer, 2011).14

In sum, for partly empirical, theoretical, and even normative reasons it is far from convincing that all and only intuitive judgments are due to heuristics. The dual-systems approach in which this claim is embedded has the smell of being too light on conceptual and theoretical reflection. But rather than dwelling on these and other issues (see Evans, 2012), I would like to close with another fundamental problem of Kahneman and Tversky’s account of intuition, of importance for both psychologists and philosophers.

4. There is a notable inconsistency in Kahneman and Tversky’s concept of intuition. It occurs mostly in responses to Laurence J. Cohen’s (1979, 1980a, 1981) well-known attack against the heuristics-and-biases message that the failures of subjects to conform to the rules assumed in the reasoning tests reveal a persistent and ineradicable irrationality. Cohen’s main objection proceeds in two steps: (1) The data coming out of Kahneman and Tversky’s reasoning tests can be interpreted differently. Most importantly, they might show performance mistakes, but not a lack of underlying reasoning competence. (2) With regard to competence, Cohen claims that human irrationality cannot be experimentally demonstrated: The norms of reasoning – against which human performance is checked in the empirical studies – are at least largely normatively valid because they are expressive of our very reasoning competence. Detecting the best set of norms of rationality is a matter of achieving a “reflective equilibrium”: an iterated application of balancing basic intuitions about particular inferences with general principles, until one achieves a comprehensive and systematic normative theory (Cohen, 1981, pp. 318–323; cf. Goodman, 1965, pp. 63ff). We may go astray in many ways but, ultimately, we have no other source for norms of reasoning than some form of reflective equilibrium, and our most sustainable intuitions play an important role here. Moreover, the very norms of reasoning used in psychological experiments must not be taken uncritically from textbooks in logic or probability theory and statistics – since there are also substantive disputes in these disciplines. Perhaps subjects have a different, but also reasonable, norm on their minds when responding to the Linda problem, tasks about base rates, sample sizes, and so on.

This last point has been called the “reject-the-norm”-strategy (Stein, 1996), of which some of Gigerenzer’s objections also form a variety (e.g., 1991, 1996). For instance, Cohen has argued that the “Baconian” theory of probability that he developed earlier on (Cohen, 1970) might be used for reinterpreting the subjects’ responses more charitably. He had devised this theory as a refinement of a tradition of probabilistic thinking that goes from Bacon over Hume to John Stuart Mill, dealing with inductions concerning causal hypotheses in science, medicine, or the courts (Cohen, 1980b). Cohen did not claim that Baconian probability should replace Bayesianism or another theory. Instead, they were supposed to play different, complementary roles. In any case, the theory of probability is certainly not immune to criticism, refinement, and revision.

Of course, Kahneman and Tversky have tried to defend their choice of norms. In the course of this, they have appealed to intuitions in order to claim that the very rules of logic and probability used in their tests are precisely the ones we should use.

Cohen’s system does not provide a viable explication of the intuitive notion of probability.

(Kahneman & Tversky, 1979, p. 409)

...the intuitive appeal of the axioms of rational choice makes it plausible that the theory derived from these axioms should provide an acceptable account of choice behavior.

(Tversky & Kahneman, 1986, pp. 535ff)

What these statements imply should be clear. In these passages, Kahneman and Tversky claim that there are some intuitions that support the normative validity of standard norms of probability and decision theory, particularly the rules assumed in their reasoning tests. About the notion of intuition used in such statements, however, Kahneman and Tversky do not tell us anything. This would clearly be needed, given that they otherwise frequently argued that intuitive judgments cannot be relied on. In this vein, Cohen remarked:

We in any case expect, since we are no longer in the Middle Ages, that serious contributions to science should rest on deeper foundations than impressionistic appeals to intuition, common sense and ordinary usage. But, even apart from the general worthless of such an appeal in a scientific context, its testimony is patent inadmissible on behalf of Kahneman and Tversky’s theory. In experiment after experiment they claim to have secured confirmation for their hypothesis that intuitive judgments of probability are prone to fallacy. They are therefore not entitled, when they need support for their theory, to assume without further argument that this or that intuitive judgment of probability is not fallacious. Kahneman and Tversky have cut the ground from under their own feet. Either the intuitive judgments to which they now appeal are those of untutored laymen, a category of humans whose accuracy of probabilistic reasoning they have long been systematically impugning. Or instead they have in mind the judgments of those, like themselves, who have received conventional professional training in statistical
methods and whose testimony on the present issue is therefore inevitably biased and irrelevant.  
(Cohen, 1982, p. 385)

Much ink has been spilled arguing that Cohen’s examples that a “Baconian” probability could be underlying intuitive judgments of experimental subjects are unconvincing. Also, some have claimed that he is too naive about the notion of intuition, or that he takes them too much for granted in his attempts to charitably reinterpret the responses of subjects who, for instance, seem to have committed the gambler’s fallacy or neglect base rates (e.g., Bishop & Trout, 2005, pp. 126–132; Evans & Pollard, 1981; Kahneman & Tversky, 1980; Kahneman, 1981; Stanovich, 1999, pp. 24–28). Obviously, Cohen’s is a concept of intuition that plays a role in philosophical analyses of concepts or the justification of normative theories. But he does not view intuitions as the sole basis of normative theories (contrary to what is asserted by Stanovich & West, 2000, p. 650). They are one important ingredient in finding a reflective equilibrium, but just one. Nor is it Cohen’s claim that intuitions are never mistaken at all. He is not an “intuitionist” (Kahneman, 1981, p. 340) in such stronger senses of the word. As he says, “impressionistic appeals to intuition” alone cannot be the basis of current science.

Moreover, none of these issues even touches Cohen’s basic worries about Kahneman and Tversky’s concept of intuition: (i) their use of intuition talk is inconsistent; (ii) insofar as they use intuitions to defend their favorite norms, then these are intuitions due to a training in probability and statistics favoring a certain norm, and so – on pains of circularity – these cannot be appealed to when that norm’s validity is at stake. I do not see that Kahneman and Tversky have ever responded to these charges.

In the discussion between himself and Kahneman and Tversky, Gigerenzer has repeated objection (i), applying it in the discussion about the Linda problem. He noted, first, that there is some empirical evidence that even untutored intuition seems able to draw conceptual distinctions of the sort statisticians and philosophers make, such as between judgments of subjective probability and those of frequency (cf. e.g., Lopes, 1991; Teigen, 1983). Second, for the frequentist statistician single-event probabilities make no sense. So, using them in the Linda problem is at least questionable. In their defense of the meaningfulness of single-event probabilities, Tversky and Kahneman (1996, p. 386) again resorted to (even laypersons’) intuitions about this and about the validity of the conjunction rule. Gigerenzer (1996, p. 593) justly finds this incompatible with their numerous other statements about intuitive judgments.

Kahneman and Tversky (1982a, p. 124f.) have, in the statement cited at the beginning of Section 3, distinguished between different things to which we apply the term “intuitive,” one class being intuitions about formal rules. This statement stems from the year after the debates with Cohen and is perhaps an attempt to come to terms with his challenge. It is, however, unsuccessful. As shown in the discussion of this statement, they did not provide a sense of “intuitive” distinct from the one used in judgments based on heuristics. So, they ascribe a role to intuition as evidence for their own favorite normative theories, but then their views are threatened by circularity. Alternatively, they are highly inconsistent about their use of the concept.

These points must be added to the objections discussed above, namely that Kahneman and Tversky’s have not shown that judgments are intuitive in the sense of being perception-like, and that all and only intuitive judgments should be brought about by heuristics. It is surprising, and even worrying, that a concept used so often throughout their work, so central to it for explanatory and evaluative purposes, and now so popular due to Kahneman and Tversky’s impact, is reflected on so very little in their own work, even after they have been challenged to think about it. We should be hesitant to use their views about intuition further. We have all the reasons to carefully revise or replace them.

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REFERENCES


Intuition in Kahneman and Tversky's Psychology of Rationality


NOTES

1. The metaphor of the mind as statistician can be found in Brunswik’s writings since the early 1940s, e.g., “All a finite, sub-divine individual can do when acting is – to use a term of Reichenbach’s – to make a post, or wager. The best he can do is to compromise between cues so that his post approaches the ‘best bet’ on the basis of all the probabilities, or past relative frequencies, or relevant inter-relationships lumped together” (Brunswik, 1938b, p. 59).

2. For instance, Brunswik was probably aware that the term “unconscious” might have been understood as having Freudian connotations. “Instinctive,” in turn, might have been seen as implying some drive or biological urge, “instinct” being the translation of the German Trieb. Both connotations did not fit with Brunswik’s ideas. I owe these suggestions to Annette Müllerberg and Horst Gundlach.

3. They excluded the psychological decision literature, pointing to research in this area: Becker and McClintock (1977) and Edwards (1954, 1961).

4. It should be noted that Edwards, surveying research on decision making, was perhaps a bit less optimistic than Peterson and Beach. Thus, he mentioned experimental games performed by the mathematician Merrill Flood, showing “that even experts on game theory are less rational than game theory might lead experimenters to expect” (Edwards, 1954, pp. 409f). Flood had also conducted experiments with his own three children, asking them to bid in a reverse auction for an attractive baby-sitting job. The teenagers seem to have known about such auctions and were perhaps trained by their father in related rational choice topics. Nonetheless, despite being allowed to form coalitions, Flood’s offspring were unable to reach an agreement even after a week. Also, the final individual winning bid of 90 cents was, according to the pay-off matrix flood calculated, quite irrational. He proceeded to declare such behavior rather commonplace, seeing it even in the U.S.-Soviet relations and their nuclear strategies (see Erickson et al., 2013, ch. 1).

5. Tversky, who died in 1996, could not be a recipient of the prize. As Kahneman (2003) emphasized in his Nobel lecture, the prize was given for work that resulted from their collaboration, especially for prospect theory (Kahneman & Tversky, 1979).

6. I am using here the familiar semantic distinction between sense and reference (also described as the distinction between connotation and denotation or extension and intension). I do not need to commit myself here to any particular version of it, Fregean or otherwise.

7. Gigerenzer (2008, p. 69) claims that it was the philosopher L. J. Cohen – about whom more in section 4.4 – who introduced the term of art “cognitive illusion” (see Cohen, 1981, p. 324). That is not true. Kahneman and Tversky used it earlier on (e.g., Kahneman & Tversky, 1977, p. 2), and it clearly fit with their concept of, for instance, the “illusion of validity.”

8. Sometimes it is said, with reference to Kahneman, Tversky, and their collaborators, that “intuition has been equated with heuristic processing” (Betsch, 2008, p. 8, emphasis added). I do not think they really made this claim. It would imply that, given that heuristics operate subconsciously, so would be intuition, a claim made apparently by other psychologists, as Osbeck (1999, p. 231) indicates. But if intuitive judgments were subconscious, then (a) how could a subject be quickly aware of them in response to certain tasks and (b) how could reports of intuitive judgments form the very database of Kahneman and Tversky’s studies? Another reading has it that they (and others along with them) view intuition as the “basis for judgments made rapidly and easily” (Osbeck, 1999, p. 231; emphasis added). This is probably an understanding of ‘intuition’ as an underlying capacity for certain judgments rather than as an ‘attribute’ of them. Some passages in Kahneman and Tversky’s work sound that way, but they are not typical or central.

9. Definitions of scientific concepts can and should at least in part be due to empirical knowledge, as philosophers as different as Kant and Kripke have argued.

10. The objection to this aspect of Kant’s doctrine of illusions of reason is not new. See Grier, 2001, pp. 4–5.

11. For simplicity, I ignore other features ascribed to the two systems, as well as the varieties of this approach. Stanovich has meanwhile developed a tripartite division, but this affects only his views on “System 2,” which he differentiates into two system, the “algorithmic” and the “reflective” mind (Stanovich, 2010). His views on the intuitive “System 1” remain unchanged.

12. Another option might be to question the assumption that the logic people use must conform to classical propositional logic. Perhaps some apparent mistakes can be understood better by non-classical logics? This is the strategy of Stenning and Van Lambalgen (2008). I admit that I am a bit skeptical about this, although I cannot argue this here. It seems to me that many of the possibilities to reinterpret apparently fallacious behaviors have more to do
with semantical ambiguities of natural language, or with the pragmatics of the reasoning tasks rather than with strictly logical features.

13. One need not maintain, as Betsch (2008) has done, that heuristics are generally used for deliberation, and that the true sources of intuition have not yet been understood in accounts of judgment and decision making.

Creative Intuition: How Eureka Results from Three Neural Mechanisms

PAUL THAGARD

INTRODUCTION

When Archimedes shouted Eureka, "I have found it," he was experiencing self-consciousness of creativity: he became aware and excited that he had produced a new and valuable idea. Understanding this phenomenon is the ultimate challenge for cognitive science, because it requires simultaneous solution of three of its major problems: the nature of the self, consciousness, and creativity. This chapter will argue that all three problems have the same solution based on three fundamental brain mechanisms: neural representation, recursive binding, and interactive competition. Creative intuition is not a mysterious process of divine inspiration or Platonic apprehension of ideas, but rather the result of identifiable neural processes that operate in all humans. These processes are mechanistic, in that they result from the interactions of parts that produce regular changes (see, e.g., Bechtel, 2008).

The historical record is insufficient to determine whether Archimedes really did shout Eureka (when taking a bath gave him an idea for measuring the volume of irregular solids), but there are undoubtedly real examples. For example, Darwin (1875) recorded in his notebook his realization in 1838 that biological evolution could result from natural selection among competing organisms. Many of us have experienced lesser moments of illumination with the same cognitive and emotional structure. For example, here is how I got the idea for my theory of explanatory coherence (Thagard, 1989, 1992). On a Saturday night in spring of 1987, I was in a movie theater watching a boring movie, Beverly Hills Cop II. For the previous few weeks, I had been excitedly programming a neural network model based on the insight of my collaborator Keith Holyoak that analogical mapping might be a process of parallel constraint satisfaction (Holyoak and Thagard, 1989). The movie was tedious, so I got to thinking about how well the computer program was