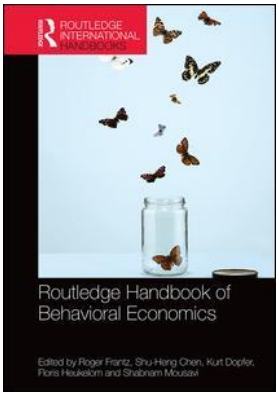

Routledge Handbook of Behavioral Economics

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Publication details
https://test.routledgehandbooks.com/doi/10.4324/9781315743479.ch9
Floris Heukelom
Published online on: 27 Jul 2016

How to cite :- Floris Heukelom. 27 Jul 2016, *Daniel Kahneman and the Behavioral Economics of Cognitive Mistakes from:* Routledge Handbook of Behavioral Economics Routledge
Accessed on: 26 Mar 2023
https://test.routledgehandbooks.com/doi/10.4324/9781315743479.ch9

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DANIEL KAHNEMAN AND THE BEHAVIORAL ECONOMICS OF COGNITIVE MISTAKES

Floris Heukelom

Introduction

Daniel Kahneman (b.1934) is one half of the Kahneman–Tversky dyad that rose to prominence in the 1970s through their work on heuristics, biases, and prospect theory. Subsequently, Kahneman, together with Richard Thaler (Chapter 8 this volume) and Eric Wanner in particular, initiated a new program on the border of economics and psychology, for which they quickly appropriated the label of behavioral economics. Based on these contributions, Kahneman received the Nobel Prize in economics in 2002. In this chapter I will first provide an overview of Kahneman's work, based on Heukelom (2014). Thereafter, I will briefly situate Kahneman's work in the history of the mind–body distinction, show how Kahneman's work is one example of the methodological problem that everything is evolution, and set out why Kahneman's work is best seen as an illustration of postwar American pragmatic liberalism.

The chronology of Kahneman's contributions

Kahneman obtained a BA from Hebrew University in 1956 while working as a psychologist in the Israeli army. In 1958 he moved to San Francisco and obtained a PhD from the University of California at Berkeley in 1961 under the supervision of Susan Ervin (b. 1927). After completing his PhD, Kahneman returned to the Psychology Department at Hebrew University where he would remain until 1978. In the meantime, however, he was among others a lecturer in the graduate program of the University of Michigan in 1968/9. While teaching at Michigan Kahneman invited his younger colleague Amos Tversky (1937–96) to lecture a class on recent developments in judgment and decision making (Kahneman, 2002).

Based on Kahneman's recollections in his autobiography and the one publication that emerged from it, his early work for the Israeli army in the early 1950s and at the Hebrew University is best characterized as correlational psychology (Kahneman and Ghiselli, 1962; Kahneman, 2002; Danziger, 1990, 1997; Gigerenzer, 1987a, 1987b). Correlational psychology builds theories on the basis of correlations in statistical data; for example, between IQ and the degree of education. Using methods developed by the British army in World War Two, the aim of Kahneman's early research was to develop reliable predictions about the future performance of people on the basis of character traits, be it in the army or in different kinds of jobs. For instance, to find out at an early

stage which new recruits in the army would eventually be successful leaders on the future battlefield, tests were designed to evaluate the differences between recruits with respect to a few behavioral and personal characteristics that were thought to relate to leadership capacities.

It is not difficult to see that in this kind of research the ability of the researcher to predict the future performance of the subjects investigated is an important, and perhaps the only way to measure success. A classification of new recruits in the army along different dimensions might be an interesting exercise, but if it does not predict better than chance, then it is of no use. In his autobiography (Kahneman, 2002) Kahneman recalls how frustrating it was when time and again he was confronted with the fact that his predictions were anything but reliable. Extensive questionnaires and tests were set up, but in the end it turned out that the intuitive guesses of the staff members who conducted the tests and collected the questionnaires proved better than the scientific predictions.

Dissatisfied with the results of this research and eager to develop his research skills, Kahneman switched to the experimental psychology of vision, resulting in some twenty-five articles over a period of ten years, including two publications in *Science*, and a whole range more in prominent experimental psychology journals such as the *Journal of Experimental Psychology*. There is no one particular theme or article that stands out during the decade from 1961–71. Kahneman's overarching view of the human mind emerges when the different themes and articles are considered next to each other.

In 1962–3, Kahneman set up a vision lab at the Department of Psychology of Hebrew University (Kahneman, 2002: 6). Many of the articles he published in the following years were derived from the experimental results of this lab. In this research, Kahneman investigated the relationship between the "energy" of different stimuli and visual perception capacities. "Energy" was employed as a general concept to define the strength of a stimulus; the brighter, the more illuminated, the more contrasted, the longer and so forth the stimulus was, the more energy it had. Visual perception was measured in terms of the reaction times of the subjects. In the typical experiment, the subject had to decide as quickly as possible whether the opening of a so-called Landolt C was directed up-, down-, left-, or right-wards.[1] The conditions in terms of brightness, contrast, and so on in this setting could be varied in numerous ways. The visual task could also be combined with other cognitive tasks. Kahneman's textbook on the psychology of vision and attention, *Attention and Effort* (1973), was still used in the early twenty-first century as standard reference on the subject (Dawes—interview, 2008).

Examples of this research include Kahneman (1965a), "Control of Spurious Association and the Reliability of the Controlled Variable" and Kahneman's (1966), "Time-Intensity Reciprocity in Acuity as a Function of Luminance and Figure–Ground Contrast." In Kahneman and Norman (1964), the relation between the minimal amount of time subjects need to identify a visual stimulus (labeled the "critical duration" t_c) and the energy in terms of brightness and duration of the stimulus was investigated. It was shown that stimuli of equal energy do not necessarily produce the same critical duration and that a given visual stimulus does not trigger one but multiple sensory processes. The second conclusion particularly opposed the general view held in the psychophysical community that one stimulus triggers only one sensory process.

In the psychophysical paradigm Kahneman was working in, visual perception was seen as one of many cognitive tasks. Other cognitive tasks included conversation, or more generally, speech, learning, and calculation. How different cognitive tasks influence one another was investigated in Kahneman and Beatty (1966, 1967), Kahneman et al. (1967, 1968), and Kahneman, Peavler and Onuska (1968). The explicit emphasis in these articles was on how the combination of different cognitive tasks could lead to "errors of judgment." In Kahneman et al. (1967), for instance, it was shown that the capacity to visually perceive substantially decreases when subjects were engaged in

other mental tasks such as speech or calculation. The "error of judgment" in these cases is very real, as it explains for instance why car drivers may miss a stop sign when engaged in conversation. It again illustrates Kahneman's focus on the psychology of mistakes.

Thus, in Kahneman's vision research an emphasis was placed on the question under which circumstances the human mind makes cognitive errors. Kahneman showed that there is a trade-off between different cognitive tasks in perception capacities, and that as a result people may sometimes "fail" to perceive the stimulus and make an error in judgment. Furthermore, the research conducted by Kahneman in the period between 1961 and 1971 was in line with the behaviorist drive to eliminate all introspection from psychology started in the interwar period (Danziger, 1997). In Kahneman's experiments self-reports were not necessary to establish how the cognitive system operates. The behavior of the cognitive system could be inferred from observed behavior and physical responses which cannot be controlled, such as pupil dilation and restriction. The human mind was considered to not permit introspective access, while its functioning could be inferred from the uncontrollable and unconscious responses made by the individual subjects.

Both elements are important in gaining an understanding of Kahneman's psychology and his subsequent influence on Thaler and other economists. The recurring theme of the cognitive errors shows that in Kahneman's view psychology was about discovering how people deviate from a norm behavior. This aspect of experimental psychology dates back to the beginning of experimental psychology in nineteenth century Germany. But in nineteenth century German and interwar American experimental psychology, this framework was adopted for the purpose of discovering what the true value was. The experimental psychologists wanted to know the true value of, for instance, the smallest amount of difference in weight people could perceive, and for this purpose devised a framework, which in spite of all the individual errors, could establish the true value (Fechner, 1860; Heidelberger, 2004; Boring, 1929). Thurstone, for instance, wanted to measure the attitude towards religion of a group of people, and for this purpose he constructed a method that would elicit the attitude from a series of observations in which each individually deviated from the true value (Thurstone and Chave, 1929). Thus, experimental psychology was explicitly modeled after experimental practice in physics, where the physicist tries to establish the true value of the temperature of boiling water by conducting a series of measurements in which each measurement individually deviates from the true value and from each other.

Kahneman employed the experimental psychological framework, but applied it differently. In Kahneman's work the true value was known. The true value was an accurate prediction of a recruit's future leadership capacities, or the true value was not running through a traffic light when driving a car. The question Kahneman then raised was how, when, and why the cognitive machinery fails to act according to the true value. Kahneman used an experimental psychological framework, but applied it with the opposite purpose. He did not want to find out what the true value was, but how people deviate from the true value. In Kahneman's research, the true value was always clear and determined by the experimenter. Kahneman knew how the cognitive machinery ideally responds, and investigated whether it actually does do so. In Kahneman's understanding, the scientist thus completely determined in each experimental situation what the good, optimal, or rational behavior should be. This was in line with the scientific desire to eliminate all introspection because it assumed that the experimental subject cannot judge whether it is giving the correct response or not. In Kahneman's experiments the experimenter determined how the subject should behave and determined how it did behave. All authority for judging behavior was placed in the hands of the scientist.

Because Kahneman has never provided an extensive theoretical exposition of the assumption that human beings often make cognitive errors, one could easily dismiss it as merely a nice way of

illustrating theories which are perhaps not too exciting. But that would be a mistake. The key to understanding Kahneman's psychology lies in his conviction that human beings often make cognitive errors. Kahneman and his colleagues really believed that through their extensive studies they could accurately predict, or at least predict better than by mere chance, the future performance of different candidates for a job. The fact that they could not was for the young Kahneman a true cognitive illusion that he needed to correct for himself (Kahneman, 2002).

Another illustrative example recalled by Kahneman in his autobiography was the moment a flight instructor disagreed with the psychologists' theory that praise is more effective in developing skills than punishment. The flight instructor reasoned that although he praised the good performance of his recruits, the next time the performance would almost always be worse. Similarly, he would always punish recruits who had done a poor job, and this would almost always improve performance the next time. To Kahneman this was a clear cognitive illusion. A good performance is statistically more likely to be followed by a worse performance than by an equally good or even better performance, and vice versa. Also the truck or car driver described above who was engaged in a conversation and thus did not see a traffic light that he or she would otherwise not miss, really did make an error. His or her cognitive apparatus was tuned to noticing traffic lights, but it failed to do so.

To Kahneman it was and is a given fact of life that human beings often make cognitive errors. However, science could help in two ways. First, scientists could set out what the correct way of behaving is for each situation. For the truck driver, it is obvious what the correct behavior is, but for the flight instructor it may not be intuitively clear what the correct way of reasoning is. Scientists can, therefore, help to establish the correct way of reasoning. Second, scientists, and in particular psychologists, could help by investigating when, how and in what way human beings make cognitive errors and thus provide a basis for designing tools or education to help human beings correct these cognitive errors.

In 1969 Kahneman and Tversky started a collaboration that would result in 21 papers and two co-edited books, including one published together with Slovic. They continued to co-operate on different projects until Tversky's death in 1996, but the most productive and creative period was from 1969 to 1979, including the widely cited 1974 *Science* and 1979 *Econometrica* articles.[2] The cooperation was initiated by Kahneman, who was looking for new ways to experimentally test his intuition that an individual's cognitive apparatus systematically fails, and who tried to find a theory that might account for these cognitive errors.

Kahneman and Tversky's joint work became a mix of their earlier individual research. Tversky's work on decision theory, with its distinction between the normative and descriptive realm, became coupled with Kahneman's psychology of mistakes. For their first article, Tversky posed a set of questions to 84 participants who attended the 1969 meetings of the American Psychological Association and the Mathematical Psychology Group that meant to capture Kahneman's personal experience of incorrect research planning and unsuccessful replications. "Suppose," Kahneman and Tversky asked, "you have run an experiment on 20 Ss [subjects], and have obtained a significant result which confirms your theory ($z = 2.23$, $p < .05$, two-tailed). You now have cause to run an additional group of 10 Ss. What do you think the probability is that the results will be significant, by a one-tailed test, separately for this group?" (Kahneman and Tversky, 1972: 433). According to Kahneman and Tversky, the answer depends on the exact interpretation of the information provided. However, it should be below but close to 0.5, they argued. Nine out of the 84 participants gave answers between 0.4 and 0.6, which Kahneman and Tversky interpreted as "reasonable." The other 75, however, gave answers that exceeded 0.6. The median response of all participants was as high as 0.85. Thus, even those professionals who were trained and who were explicitly asked to give the normatively correct answer failed to calculate it

correctly. Kahneman and Tversky felt justified in inferring the strong and bold thesis "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" (Tversky and Kahneman, 1971: 105).

To the retrospective outsider, the question seems much too detailed for conference participants asked to fill out a questionnaire in between conference sessions, even if they are professors of psychology. But while it is undoubtedly true that Kahneman and Tversky formulated the question such that the desired result would be likely to appear, the formulation of the question is also a testimony to the perceived superiority of scientific language, and science in general. To Kahneman and Tversky, as to many of their contemporaries, human behavior had to be measured and judged against the yardstick of science. Therefore, the scientific wording could not be bent too far in the direction of imperfect human understanding. However, where many of their contemporaries took similar experimental falsifications of individuals' capacity to reason along scientific lines as proof that something had to be wrong with the science (e.g. Ellsberg, 1961; Allais and Hagen, 1979; Baumol, 1951, 1958; Simon, 1955, 1959; Slovic and Lichtenstein, 1971), Kahneman and Tversky took it as evidence of a cognitive failure of the individuals tested. They found it appalling and fundamentally disturbing to see that even trained professionals failed to behave according to the dictates of normative theory.

Taking an idea from the learning theory of Estes (1964), Kahneman and Tversky hypothesized that individuals have the tendency to suppose that a sample from a population must represent the population in its general characteristics. In other words, they implicitly accounted for their results by supposing that the biological make-up of human beings makes individuals ignore the possibility that a sample of a population may not be an accurate representation of that population. Kahneman and Tversky hypothesized that this provides individuals with the wrong intuition and that as a result they fail to give the right answer. However, Kahneman and Tversky took the research of Estes (1964) a step further by concluding that if individuals systematically consider a sample to be representative of its population, then it could be thought of as a "heuristic." They advanced the idea the human mind uses this heuristic to base decisions on.

The reason why the majority of scientists and lay persons systematically deviated from the norm-answer that was given in Tversky and Kahneman, "Belief in the Law of Small Numbers" (1971), and further developed in Kahneman and Tversky, "Subjective Probability: A Judgment of Representativeness" (1972), was that human beings, in general, do not base their decisions on the normative laws of, in this case, probability theory and statistics, but instead use a "representative heuristic." Kahneman and Tversky described the representative heuristic as the phenomenon that "[t]he subjective probability of an event, or a sample, is determined by the degree to which it: (i) is similar in essential characteristics to its parent population; and (ii) reflects the salient features of the process by which it is generated" (Kahneman and Tversky, 1972: 430). In the example the individuals interrogated supposed the draw to be a good representation of the population the experiment was meant to say something about, and focused on the salient feature of the test, namely that it confirmed the theory significantly. As a result of this representative heuristic, most of the professional psychologists estimated the probability requested to be much higher than it actually was (as said, the median estimate was 0.85).

Because human beings have much more faith in small samples than they should, Kahneman and Tversky half jokingly labeled this phenomenon the "belief in the law of small numbers," in reference to the law of large numbers. The analogy with faith and belief cast the issue in terms of subjective religion, prejudice and limited knowledge versus objective, value-free science; it characterized the observation in terms of the incapable individual versus the rational, enlightened

scientist. In other words, it expressed Kahneman and Tversky's view that an individual's erroneous behavior is the result of false beliefs for which the individual—including even the professor of psychology—cannot really be blamed. The "deviations of subjective from objective probability seem reliable, systematic, and difficult to eliminate" (Kahneman and Tversky, 1972: 431), and "[t]he true believer in the law of small numbers commits his multitude of sins against the logic of statistical inference in good faith. The representation hypothesis describes a cognitive or perceptual bias, which operates regardless of motivational factors" (Tversky and Kahneman, 1971: 109). In Kahneman and Tversky's framework, science, and in particular mathematics, decision theory and economics, determined what were the normatively correct decisions in each decision situation. In this framework, normative was equated with rational and objective. The actual decision made by the individual was part of a "descriptive" or "subjective" realm, and could be either in accord or in disaccord with the normative or rational benchmark. If in disaccord, this implied the individual had made an "error," "mistake," or, in the language of behavioral economics from the early 1980s onwards, an "ir-," "non-," "not fully," or "boundedly rational" decision.

The alternative theory Kahneman and Tversky proposed was their heuristics and biases theory, first labeled as such in Tversky and Kahneman (1974), "Judgment under Uncertainty: Heuristics and Biases." In this theory, people do not use the normative theories of probability and logic to make decisions under uncertainty, but instead rely on a number of heuristics, heuristics that sometimes lead to systematic deviations. In the often quoted definition of the theory, heuristics and biases "shows that people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors" (Tversky and Kahneman, 1974: 1124). Kahneman and Tversky emphasized the importance and functioning of a few heuristics, such as representativeness, availability, and anchoring. But by no means was the heuristics and biases theory meant to remain confined to these few heuristics. There was no limit to the number of heuristics that possibly could be discovered in humans' minds. The heuristics and biases program summed up the many violations of the normative models Kahneman and Tversky had found, and provided a small, non-exhaustive list of explanations that might account for these violations.

The term "heuristic" appeared for the first time in 1971 without any precursors in either Kahneman's or Tversky's earlier work, and from the beginning was used without introduction as a natural term for an intuitive response. In the 1950s to the 1970s Herbert Simon had used "heuristic" and similar terms in his uncompromising attack on the—what he understood to be—behavioral foundations of neoclassical economics, and the alternative he proposed in the form of human decision making based on heuristics (e.g. Simon, 1955, 1959, 1963, 1986). It is, therefore, tempting to conclude that Kahneman and Tversky's use of the term somehow derived from Simon. But that would be a mistake. As illustrated by Kahneman and Tversky's use of the term, "heuristic" "was just a word from the language" (Kahneman—interview, 2009). Simon used the term in a different way and is moreover not mentioned in Kahneman and Tversky's research of the early 1970s.

It is useful to briefly set out the difference between the two. In Simon's view, individuals use rules of thumb or heuristics to make decisions. An example of a heuristic could be to set an aspiration price for the house one wishes to sell, and to go with the first offer that exceeds the aspiration price. Or, alternatively, the heuristic could be to accept the best among the first n offers (e.g. Simon, 1955). To Simon, such a heuristic was meant to optimize the decision made given all the constraints the individual faced in terms of information, cognitive capacity, and time. If the heuristic yielded a satisfactory outcome it would be maintained, if not it would be adjusted. Importantly, to Simon the heuristic's function was not to approximate the global optimum given

all the possibly relevant information and computing capacity, but to achieve a satisfactory outcome given the information and capacity that one had.

In Kahneman and Tversky's approach, by contrast, the function of heuristics was to simplify and reorganize the decision problem in such a way that it was manageable for a not very sophisticated decision maker. The heuristics' objective was to approximate the optimum given all relevant information and full knowledge of statistics, logic, and expected utility theory. The heuristics did not yield the decision, but reorganized the informational input in such a way that a decision making process was possible. In the birth order problem, for instance, individuals, as said, commonly believe a family of G B G B B G instead of B G B B B to be more likely because it better represents the individual's image of a family of six children (representativeness) or because it has such a family more readily available (availability). In other words, the availability heuristic links the incoming information to already present information about six-children families so as to simplify the decision. In this case, however, that organization of the information leads to the wrong conclusion. And because the heuristic is part of the biological make-up of the individual, it will not change. If the question is given more thought, the individual may opt for both options to be equally likely, particularly if the individual has just taken a course in logic and statistics. That is to say, the individual may override its own intuition using its capacity to reason. But the individual's initial intuitive response will always be the first option to be more likely.

In 1979 Kahneman and Tversky published their now famous article on "Prospect Theory: An Analysis of Decision under Risk" in *Econometrica*. The article marked a shift in emphasis away from probabilistic decision problems to an investigation of people's capacity to behave according to the normative theory of expected utility theory. It was the first attempt to produce a more complete descriptive theory of human decision making under uncertainty. Prospect theory has often been presented as being different from heuristics and biases (e.g. Kahneman, 2002), and it is certainly true that prospect theory brought the different heuristics into one overarching framework. But the foundation still was the idea that human beings rely on a set of heuristics for their decision making and that the use of these heuristics sometimes leads to systematic deviations from the normatively correct decision. In this regard it is to be noted that it took Kahneman and Tversky some five years to get the article published in *Econometrica*, and that the last four of these five years were used to tweak what was for the most part a finished argument to fit an economic audience (Kahneman, 2002, interview, 2009).[3]

Kahneman and Tversky made the connection with their earlier work in the first few lines of the 1979 article, which set out the conception of expected utility theory as a normative theory that also makes descriptive claims:

> Expected utility theory has dominated the analysis of decision making under risk. It has been generally accepted as a normative model of rational choice, and widely applied as a descriptive model of economic behavior. Thus it is assumed that all reasonable people would wish to obey the axioms of the theory and that most people actually do, most of the time.
>
> *(Kahneman and Tversky, 1979: 263)*

In a clever way, these opening sentences alluded to both the psychological and the economic framework. To psychologists these sentences restated a well-known normative–descriptive framework and signaled a contribution to an established field of research. Positivist economists in the line of Friedman (1953), on the other hand, might have raised their eyebrows at the injunction of the "normative," but they would certainly have agreed that reasonable people wish to obey the axioms of expected utility theory and that they actually do so, or at least most of the

time. Note, furthermore, that Kahneman and Tversky carefully avoided the term "rational," and used "reasonable" instead. Invoking the term "rational" might have suggested that this was an article in the line of critique of economics. The use of "rational" would certainly have induced some economists to think that these two psychologists had the same research program as Simon, who had won the Nobel Memorial Prize in economics the year before. From the start, prospect theory was carefully constructed so as to be able to broaden the scope to economists especially.

The content of prospect theory is well-known. As in heuristics and biases, Kahneman and Tversky based their argument on a series of hypothetical questions they had presented to experimental subjects, in this case psychology students at Hebrew University. The problems the subjects were presented with were decision problems, involving different material outcomes and different probabilities. Most of the questions were reformulations or variants of Allais' decision problems (Allais, 1953; Allais and Hagen, 1979). One example of Kahneman and Tversky's use of an Allais-type approach is in the question where subjects were asked to state which of the following lottery options they preferred.

A: (4,000, .80) or B: (3,000)

That is, they were asked whether they preferred 4,000 shekel with a probability of 0.8, or 3,000 shekel for certain.[4] Most of the subjects in this case chose B. This implied that they did not maximize the expected monetary outcome. However, opting for the choice B could be explained by assuming that the decision maker was risk averse. Subsequently, subjects were asked which of the following two lottery options they preferred.

C: (4,000, .20) or D: (3,000, .25)

In this case, most of the subjects chose C and, hence, maximized the expected monetary outcome. This was problematic in combination with the first choice as it implied that subjects were sometimes risk averse, but on other occasions maximized the expected monetary outcome and hence were not risk averse. Note that the second choice is equal to the first with probabilities divided by four. With these and similar examples, Kahneman and Tversky illustrated that despite its normative status, expected utility theory as a descriptive theory was invalidated. In specific circumstances, people systematically deviated from the norms of expected utility theory. A new descriptive, "alternative account of individual decision making under risk," was therefore required. The alternative account was christened "prospect theory" (Kahneman and Tversky, 1979: 274).[5]

According to prospect theory, a human decision maker first employs a number of heuristics to make a decision problem manageable. This process was called the editing phase. Complicated decisions are broken down into different simpler decisions, different decisions are lumped together into one big decision, a benchmark is set with which the decision is compared, and so on. The purpose of this editing phase was to make the decision manageable. After this, the decision was evaluated in what was referred to as the evaluation phase. The evaluation phase had the same structure as the maximization of expected utility, but instead of the objective values of the material pay-off and probability, it used the individual's subjective perception of the material pay-off and probability. The subjective perception of the material pay-off was referred to as value (denoted v) and the subjective perception of probability was referred to as decision weight (denoted π). In expected utility theory, a subject who is faced with a choice between outcome x that occurs with probability p and outcome y that occurs with probability q derives utility according to the following function.

$$U(x,p;y,q) = p \cdot u(x) + q \cdot u(y) \quad (1)$$

in which utility u is a subjective valuation of the outcome according to the axioms of von Neumann and Morgenstern (1944) and Savage (1954). In other words, it defines how an individual values an outcome given its preferences if it behaves according to the normative rules of rational decision making. Furthermore, in the expected utility theory of equation (1) the individual perceives the probabilities of the outcomes as what they objectively are. In prospect theory, by contrast, a subject that following the editing phase faces the exact same choice will value this choice according to this function:

$$V(x,p;y,q) = \pi(p)v(x) + \pi(q)v(y) \quad (2)$$

in which v is similar to u, but based on empirical observations in experiments rather than axiomatically defined utilities; constructed with respect to an individual reference point, rather than to an objectively defined benchmark; and with a risk-seeking character in the loss-domain. In addition, the probabilities of the outcomes are not perceived as what they actually (i.e. objectively) are, but are also subject to a perception bias of the individual.[6]

The use of heuristics and the framework of psychophysics allowed Kahneman and Tversky to construct a theory in which individuals try to make the best decision, and yet could often be observed as making decisions that systematically deviate from the normatively correct decision. Individuals do their best, but because human beings apply heuristics to reconstruct decision problems to manageable proportions, and because they have a specific perceptual system which distorts the stimulus, their reasoned decisions may deviate from the normatively correct solution. Kahneman and Tversky had to cut the link between the normative and the descriptive theory in order to maintain the normative theory, while at the same time allowing for the conclusion that people systematically and persistently deviate from the norm. Human beings, who in Savage and Edwards' accounts were capable of normatively correct reasoning (i.e. normal healthy adults) could no longer be expected to behave according to the normative rules.

Ultimately, prospect theory was based on the authority of science, even if also scientists' first intuitive response could be mistaken. Prospect theory took the axioms of decision theory as the norm for behavior, and developed the measurement framework so that the experimental observations would fit. Deviations from the axiomatic norms were understood as errors or mistakes, and they bore no implications for the norms. Because of the clear separation between the normative and the descriptive, it was now possible to construct a separate account of decision making in the descriptive domain, without implications for the normative theory. In prospect theory, human beings were understood as having a biased perception of the relevant input of probabilities and pay-offs, just as they had a biased perception of sensory inputs such as temperature and weight.

Evaluation

Approaching Kahneman's work less from a historical, and more from a philosophical perspective, it is easy to observe that the central idea in Kahneman's work is that human decision making is best understood as the combined outcome of two cognitive systems. Different names and slightly different categorizations have been advanced by Kahneman over the years, with the labels System 1 and System 2 emerging as the definitive terms in the early 2000s. System 1 is the fast, energy efficient and intuitive system human beings rely on for frequently returning decisions that can be made without serious deliberations. Examples would be what to take for breakfast, and whether

or not to bring an umbrella when going out. As System 1 is fast and energy efficient, it has its obvious advantages. However, because it is intuitive and relies on heuristics, or rules of thumb, System 1 leads to sub-optimal outcomes when these intuitions do not fit the decision at hand particularly well. System 2, by contrast, is slow, requires substantially more effort and energy, but also is less likely to produce sub-optimal outcomes. System 2 is not required for frequently returning decisions, such as what to take for breakfast, but is useful for infrequent, important, or especially difficult questions. Examples include buying a house, taking an exam, or inventing a driverless car.

So which part of the brain is System 1 and which is System 2? The behavioral economic subfield of neuroeconomics has attempted to answer this question, locating System 1 principally in the pre-frontal cortex, and System 2 everywhere else (e.g. Camerer et al., 2005; Kable, 2011). That sounds a lot like phrenology, discarded as scientifically meaningless by neuroscientists in the early twentieth century. But while not denouncing neuroeconomics directly, Kahneman has emphasized that the System 1 versus System 2 dichotomy is as much a description of the human decision making machinery, as it is a metaphor that should be judged by how successful it is when helping people to discuss their decision making around the proverbial water cooler in their offices. It is as much a theory as it is a tool (Kahneman, 2011). In addition, System 1 versus System 2 stands in a scientific tradition that goes back to the origins of Western thinking, the mind–body dichotomy.

The mind–body distinction that permeates (the history of) Western thinking, is usually first of all connected to René Descartes, but in various versions goes back to the ancient Greeks (e.g. Bennet and Hacker, 2003). Descartes posited that what distinguishes the mind from the body is its ability to think, to reason. The body is the province of emotions and intuitions, and is not capable of reason. As we humans are the only beings that possess a mind, reasoning is also what distinguishes us from the animal kingdom. Moreover, sometimes the body and its emotions and intuitions produce responses the mind judges inappropriate, not useful, or in some other sense not optimal given the situation at hand. In such cases, the mind overrides the impulsive response of the body. And as it is only human beings who possess a mind, it is also only human beings who are capable of overriding the body's intuitive, emotional response.

Western culture is full of parables and examples illustrating the eternal struggle between mind and body. Odysseus knew his body would succumb to the songs of the sirens, and that his mind would not be strong enough to prevent his body from steering the ship towards them, thus inevitably killing him. Yet he wanted to hear the sirens sing. He thus let himself be tied to the ship's mast before entering the sirens' waters. In other words, Odysseus' mind recognized in advance something very desirable to his body would come up, and foresaw the impossibility of using his mind to control his passionate body at the moment it most needed to. Yet, Odysseus neither wanted to forgo the bodily pleasure of the singing sirens, and so devised a solution to have both: hear the sirens without getting killed. The solutions Kahneman offers for the failures of System 1 stand in the line of this Odyssean element in Western culture. System 2 recognizes that something desirable to System 1 is coming up, for instance a loan check that could all be spent on clothing instead of also on paying down the mortgage and saving for retirement. In addition, System 2 realizes that when the moment is there it will be unable to control System 1, and hence devises a scheme or solution. For instance, asking the employer to deposit part of the check in a pension saving scheme prior to transferring the money (e.g. Thaler and Benartzi, 2004). This scheme partly gives System 1 what it wants, but controls the excess that imperils the individual.

Over the past twenty years, a range of authors have amended and criticized Descartes' dichotomy and the mind–body tradition in which it stands. Perhaps the most fundamental

critique has arisen through the work of Antonio Damasio, Ap Dijksterhuis and others (e.g. Bennet and Hacker, 2003; Damasio, 2003; Dijksterhuis, 2006). These neurologists, psychologists, and philosophers offer two main criticisms of the Cartesian mind–body dichotomy. First of all, they argue that the distinction between mind and body is an illusion. Rather, the human brain, eyes, ears, stomach and feet are all part of one integral system which needs to be understood as such to effectively explain its output: human behavior. Second, these scientists reject the notion of a faculty of reason that is superior to emotions and intuitions. Instead, they argue that emotions and intuitions may be a different way of arriving at a decision, but that it often constitutes an effective, efficient, and perhaps even a superior way of arriving at a decision.

Although of course very well aware of these developments in neuroscience and psychology, Kahneman's work nevertheless clearly stands in a tradition of the Cartesian mind–body dichotomy. To Kahneman, emotions and intuitions may often be efficient ways of responding to everyday and well known tasks, when it becomes more difficult or the situation more unusual, support of the mind's reason, or System 2 is needed. In such cases, the mind's reason has to overrule the body's emotions and intuitions, as in the case of Odysseus.

Kahneman has connected this centuries-old dichotomy approach with insights from evolution theory. The basic principle of (Darwinian) evolution is simple enough. Given an environment with scarce resources, and a population of species in this environment the individuals of which slightly differ from each other due to random genetic variation, those individuals best adapted to random changes in the environment will produce the most offspring, and their genes will survive. Many amendments and extensions of this basic argument have been advanced, of course, but that is the basic principle (Hall and Hallgrimson, 2008).

As a thought experiment, this mechanism could be reversed. All plants and animals are the offspring of plants and animals which had an advantage over their peers at some point in the past. And so, if you have a plausible idea of the environment in the past for which the plant's shiny orange flowers, the animal's long neck, or the bird's particularly shaped beak produced a competitive advantage, you have explained why the plant or animal is thus shaped.

The same exercise could be conducted with the limits to the human cognitive machinery. Why does merely knowing a product brand increase the likelihood of selling its products? Because, throughout evolutionary history if you had encountered something several times and were still alive, the object encountered was probably good and safe (Dworschak and Grolle, 2012). Why do people often display herding behavior, and start selling shares only when all others are also selling shares? Because during the long time our ancestors spent in the dangerous surroundings of forests and savannas, it was generally very wise to first join your group in running away before carefully examining why they were running away.

The challenge arises when scientists' creative minds are combined with the little knowledge we have of past environments. For every (alleged) characteristic of every plant and animal a plausible past environment and evolutionary explanation is quickly conceived. The same holds for human beings. If you find that people are bad at statistics, because their intuitive, System 1 response is to answer based on which information is presented first (known as anchoring), our creative minds have little difficulty suggesting a plausible environment in which members of a hunter-gatherer society using the anchoring heuristics had an evolutionary advantage.

That would not be so bad, good even perhaps, if it were possible to test these evolutionary explanations. However, as it is neither possible to travel back in time to test these hypotheses, nor feasible to put some human beings in a pre-determined environment and see how they evolve over a few hundred thousand years, Kahneman's research and the research community to which it has given rise can only offer many partial explanations that it cannot decidedly validate or falsify.

Finally, Kahneman's research, and the behavioral economics to which it gave rise in particular, are best understood within the context of pragmatic liberalism in the United States—despite the fact that Kahneman was born in France, raised in Israel and only came to the United States in his early twenties. As will be well known, American society and science are strongly rooted in the seventeenth and eighteenth centuries' liberal ideals of the Enlightenment (Brands, 2010; Johnson, 1997). The Enlightenment sought to free individuals of the shackles of involuntary labor, autocratic leaders, religion, and morals.[7] A second dominant conviction in American society has been a naturalistic notion of the market. When freed to pursue their own interests, individuals will start to offer and buy products, and create the accompanying institutions they deem necessary to facilitate this economy. The market is a phenomenon that naturally emerges from a free, and liberated society. The institutions that will emerge include formal institutions such as courts and controls of quality, but also more informal institutions that facilitate the economic process (Acemoglu and Robinson, 2012; Friedman, 2005; McCloskey, 2006). And while for instance Continental European liberals changed to a more constructionist understanding of the market around the middle of the twentieth century (e.g. Nicholls, 1994; Hesse, 2010; Burgin, 2012), the dominant conception of the market in the United States has remained a naturalistic one up to the present.

That being said, something started to change in the late nineteenth century nevertheless (e.g. Pettit, 2013; Yarrow, 2010). Following a rapid economic development, including more fully developed industries and markets, the economically and politically freed Americans among others ran into the question what to do when a clever individual or company takes advantage of less well-informed consumers. Who takes precedence in the economy of liberated individuals, the free market or the free consumer?

From this perspective, the rise of American psychology in the late-nineteenth and early-twentieth century's, is best understood as an attempt to strengthen the individual in its dealings with the market (e.g. Capshew, 1999). On the one hand, this took the form of showing individuals how they might be deceived by malevolent market parties—and thus how to strengthen themselves against this element of the modern economy (e.g. Pettit, 2013). On the other hand, it took the form of testing and classifying individuals so as to improve their distribution across the different positions to be fulfilled in society (e.g. Mills, 1998). Both elements were captured under the label of mental, and later social or human engineering (Jordan, 1994; Lemov, 2005). In the words of James McKeen Cattel (1860–1944), the first professor of psychology in the United States at the University of Pennsylvania, the aim of psychology was "to describe, to understand, and to control human conduct" (Cattel, 1930: 31). The Second World War provided a strong catalyst to this engineering aspect of American society, with science and engineering stepping forth as primary components in winning the war and in organizing society. These developments also drew in psychology, boosting the discipline with a wealth of new funds, career opportunities, and areas of psychological research and application, while drawing the different branches of psychology together in one discipline of human engineering (Capshew, 1999; Cordeschi, 2002; Mindell, 2002).

Particularly explicit was Robert Yerkes (1876–1956), who stepped into the limelight during the war as the initiator and organizer of the Intersociety Constitutional Convention, which sought to reorganize the psychology profession on behalf of the American Psychological Association (APA) and a few other major associations. A gap existed, Yerkes argued, "between the human needs which are partially met by the physician and those which the clergyman or priest is expected to satisfy" (Yerkes, 1941: 535). Psychology, as the science concerned with the needs and requirements of the normal individual (as compared to the abnormal or severely maladjusted individual who required therapy or medial attention) "must stand as a basic science

for such universally desirable expert services as the guidance and safeguarding of an individual's growth and development, education and occupational choice, social adjustments, achievement and maintenance of balance, poise, and effectiveness, contentment, happiness, and usefulness" (Yerkes, 1941: 536).

In *How Reason Almost Lost its Mind* (2013), Erickson et al. show how this American program of human engineering was reformulated in terms of rationality during the early postwar period. The objective of improving humans' capacity to deal with the complexities of the economy and modern life in general, was reformulated as the idea that while normal, healthy adults in general can be understood to be rational beings, they sometimes fail to make the rational decision due to an overload of information, or misconstrued organizational structures. Otherwise, however, the program by and large remained the same: it was the psychologist's job to figure out when the individual is prone to making mistakes, and how to correct these mistakes.

During the 1970s, the emphasis of this program shifted somewhat (Heukelom, 2014; Erickson et al., 2013). Instead of assuming that normal, healthy adults in general are pretty rational and only occasionally run into difficulties when the job becomes too demanding, a new generation of behavioral psychologists, including first and foremost Kahneman and Tversky, began to emphasize that perhaps it is rather the reverse: even normal, healthy adults often behave in ways that deviate systematically and predictably from the rational norm, they argued (e.g. Tversky and Kahneman, 1974). Moreover, individuals are much more difficult to correct into making the more rational decision than thought thus far. It is to be emphasized, however, that from the perspective of engineering psychology, this was a shift in emphasis only, albeit an important shift. The objective was and remained to support individuals in taking better care of their own interests and preferences amid the complexities of modern society.

In the 1980s, a new generation of economists, including first and foremost Richard Thaler introduced this engineering approach of the psychologists, and of Kahneman and Tversky in particular, to economics, thus creating what would become the new field of behavioral economics. The central objective of these behavioral economists became to enhance the rationality of individual consumers in the economy, and thereby to increase their welfare and their position versus other market participants, such as companies (e.g. Thaler and Sunstein, 2008; Heukelom, 2014). As such, Kahneman's behavioral economics became the last example of a century-old program of human engineering, that is, of pragmatic social science, even if now applied more explicitly to economic questions.

Conclusion

Throughout his career, Daniel Kahneman has been intrigued by the question of why individuals sometimes behave counter to the, sometimes very obvious, dictates of modern science. How does the decision making machinery of the human mind work? And, why does it sometimes fail systematically and predictably? Initially, Kahneman's research focused on traditional psychological topic, such as the assessments of military recruits and the visual system. Kahneman and Tversky's "Prospect Theory" article was the first, and very successful attempt to also include economic decisions in this research program. The hint was picked up quickly by Richard, who, together with Kahneman, built a new subfield of (micro) economics for which they successfully appropriated the label of behavioral economics.

Just as any other scientific work, Kahneman's research may be put into historical context. A first observation in that regard is that Kahneman's work stands in a line of a dichotomy between mind and body that goes back to the Greeks. Just like Odysseus used his mind to devise a scheme

that would control his body amid stimuli that would risk it to self destruct, so Kahneman urges his readers to devise ways to solve the problems that the intuitive, bodily System 1 runs into when the situation at hand requires extra cognitive capacity, additional information, or more willpower. In that regard, Kahneman's work is in addition best understood as not sharing, and even implicitly opposing recent work by Damasio, Dijksterhuis, Bennet and Hacker, and others that denies the Greek–Cartesian mind–body dichotomy.

Second, Kahneman illustrates the difficulties in providing evolutionary explanations for human behavior. Given that it is relatively easy to come up with an adaptive strategy for "hunter-gatherers" that explains why human beings today tend to behave in a certain way, but at the same time difficult to validate or refute such hypotheses, explanations for the observed behavior proceed little beyond the speculative realm.

But perhaps that is not as problematic or destructive as it sounds. Kahneman's research also stands in a tradition of pragmatism and engineering that has been particularly influential in the United States, and which emphasizes the use of science in solving everyday problems of individuals and society, rather than providing fundamental explanations for why things are the way they are. Despite being a French-born Israeli, Kahneman's decades-long career in American academia has made him a principal product, as well as key contributing actor, to this particular American approach to the social sciences.

Notes

1 The Landolt C is one of the standard symbols used in psychophysics of vision and optometry. It consists of a C in which the opening can be varied, and which is either surrounded by bars the width of which equals the C's opening or not surrounded.
2 Tversky and Kahneman (1974), "Judgment under Uncertainty: Heuristics and Biases" and Kahneman and Tversky (1979), "Prospect Theory: An Analysis of Decision under Risk."
3 Initially, the article submitted to *Econometrica* was known as "Value Theory" (Kahneman, 2002).
4 At the time of the experiment, 4,000 shekel was about one third of the modal monthly Israeli income.
5 Kahneman (2002) recalls that they deliberately looked for a name that did not refer to any other theory or phenomenon in economics and psychology. Indeed, Jstor yields only one, idiosyncratic counter example. In 1977, Edmund W. Kitch of the University of Chicago developed a new economic theory for the patent system in the *Journal of Law and Economics*. "For expositional convenience, this view of the patent system will be called the prospect theory" (p. 266).
6 The experimentally induced subjective probability curve of Kahneman and Tversky (1979) suggested that the probabilities of one event space as perceived by the individual may not add up to 1, and hence violate Kolmogoroff's axioms (Kolmogoroff, 1933). Tversky and Kahneman (1992) offered solutions to this problem.
7 However, drawing on Jonathan Israel's three-tome history of the Enlightenment, among many others, we could ask just how radical the American version of the Enlightenment was (Israel, 2001, 2011). As Israel shows, some authors went further than others, with Baruch de Spinoza (1632–77) standing center stage as the first and most radical Enlightenment thinker, according to Israel. Adam Smith (1723–90), for instance, for various reasons did not want to liberate the individual as radically as did Spinoza (Israel, 2011). By and large, it seems fair to summarize that whereas freeing the individual from the economic and political shackles of Old World Europe was at the heart of the new American nation, cultural, religious and moral shackles were far less questioned.

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