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# Daniel Kahneman: on redefining rationality

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## 1. Introduction

There are two ways to research how people make judgments under uncertainty. One is mathematical. Define a minimum set of axioms necessary to obtain analytical solutions for equilibrium. Examine that equilibrium's efficiency, optimality, stability and uniqueness. Sometimes (not always), test the theory's validity by comparing its predictions with reality. A second is behavioral. Offer people (surgeons, statisticians, psychologists, ordinary people) a series of pair choices (Kahneman and Tversky, 1979, p. 267):

Would you prefer—

- |                                                                     |    |                                                  |
|---------------------------------------------------------------------|----|--------------------------------------------------|
| A. 50% chance to win a 3-week tour of<br>England, France, and Italy | or | B. (100% certain) 1-week tour<br>of England      |
| C. 5% chance to win a 3-week tour of<br>England, France and Italy   | or | D. 10% chance to win a 1-week<br>tour of England |

Observe their behavior carefully and generalize.

Both approaches are valid. They are allies, not enemies, even though behavioral findings often contradict fundamental axioms. For instance, a large majority of people pick B over A, but choose C over D (the 'certainty' principle). The axiom of substitution underlying expected utility assumes this preference reversal never happens.

Towards the end of the 19th century, economic science came to a fork in the intellectual road. On the right was Walras, who saw economics as a special case of Newton's celestial mechanics. On the left was Marshall, who defined economics as "the study of men as they live and move and think in the ordinary business of life" (Marshall, 1962). Economists chose Walras. "We curtsy to Marshall," Milton Friedman said, "but we walk with Walras" (Friedman, 1949). Beware of elegance, Einstein once cautioned. Walrasian economics was elegant, but it was not about real people, real behavior, or real reason.

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Quietly, for decades, psychologists and economists have been systematically and radically altering the fundamental concept of rationality—or *super-rationality*—that underlies Walrasian economic theory. Israeli cognitive psychologists Daniel Kahneman and the late Amos Tversky led the charge.

With the award of the 2002 Nobel Prize to Kahneman—Eugene Higgins Professor of Psychology, Princeton University, and Professor of Public Affairs, Woodrow Wilson School—the behavioral approach officially became mainstream. Amos Tversky died of cancer in 1996 at the age of 59; he would doubtless have shared the award had he lived, as Kahneman himself affirms. [See Postscript.] In the following essay, Catherine Eckel reviews the work of co-Nobel Laureate, experimentalist Vernon Smith.

I predict that the confluence of the mathematical and behavioral approaches will dominate our profession for the next generation and will create at last a powerful machine for generating both theories and pipes (i.e. policies) that hold water.<sup>1</sup> In this essay, I first survey the evolution of economics' concepts of rationality. I next review Kahneman's behavioral approach, as exemplified in what he himself calls, of all his papers, his personal favorite: "The Psychology of Prediction." Rather than conduct a detailed survey of Kahneman's 131 papers and books (see List of Publications), I then present a diary of Economic Man that reveals some of the heuristics and biases Kahneman discovered. I conclude with some observations on how the concept of rationality will likely evolve, to restore the normative foundations of economics.

## 2. The evolution of rationality

Almost 20 years ago, my wife Sharone and I surveyed the literature on behavioral economics (Maital and Maital, 1984). We cited Herbert Simon (1959), who 25 years before that had asked, "how have psychology and economics gotten along with little relation in the past?" (p. 253). We observed that economists and psychologists (still) differ vastly in two key areas: their models—how they view human behavior—and their research methods—how they validate their theories. In 1984, the "models and methods" gap between psychology and economics was wide, even though psychologists Daniel Kahneman, his friend and colleague Amos Tversky, and others had been publishing landmark studies for years.

Karl Marx observed that existence determines consciousness. By that he meant that how we live determines how we think. In the history of the intellect, more often than not how we think determines how we live—ideas, not vested interests, drive history, Keynes noted.

There is a clear but winding path from the mathematics of expected utility (Von Neumann and Morgenstern, 1944), through the psychology of bounded rationality (Simon) to the psychology of common-man rationality of Tversky and Kahneman. The title of von Neumann and Morgenstern's landmark book was *Theory of Games and Economic Behavior* (1944). In the introduction, they note: "We believe that it is necessary to know as much as possible about the *behavior* of the individual . . ." (p. 7). [My italics.] In the same paragraph, they warn against "*shortcuts*"; however, lacking adequate empirical knowledge about judgment under uncertainty, they then take one. They build an axiomatic approach toward behavior

<sup>1</sup> See the sequel to this essay, in which further explores the future direction of behavioral economics (Maital, 2003).

under uncertainty—the foundation of expected utility—that in turn makes possible modern game theory, a rich, new and rigorous theory of how people interact in situations of cooperation and conflict, one of many ‘mathematically unsolvable problems’ that von Neumann solved. Expected utility also formed the basis of the economics of finance, a powerful theory whose tools underlie large and growing capital markets.

The nine fundamental axioms of expected utility theory can be distilled into five: preferences are (i) all-embracing, or complete, and (ii) consistent, (iii) if A is preferred to B, then  $(P, A)$  is also preferred to  $(P, B)$ , where  $P$  is some probability between 0 and 1; (iv) if A is preferred to B, and B to C: the influence of A can be made as weak as desired by attaching a sufficiently small probability to it; and (v) ‘packaging’ or ‘framing’ how the choice is presented makes no difference (Maital, 1982, p. 194). All five axioms are consistently violated by choice behavior. Even when inconsistencies are noted and explained to subjects, the ‘irrationality’ persists.<sup>2</sup>

Every theory is based on assumptions that are not quite true. That is what makes it theory. What separates good and bad theory is the boundary defined by Einstein’s version of Occam’s Razor: “Everything should be made as simple as possible—but not simpler” (Calaprice, 2000). The arbiter of what comprises “not simpler” can be the pair-choice or experimental approach. When *some* people behave in ways that violate key axioms, that is one thing. When nearly *all* people do—that is a case of Einstein’s “more so.” Kahneman, Tversky and others offer reality-based axioms on which theorists can now build good theories.

The constructive schizophrenia of economics built firmly on behavioral foundations enables a two-track evolution of theory: On the one hand, how *would* markets work, and how *would* people behave, if they were “super-rational” (implemented the expected-utility and utility-maximization axioms)? And on the other, how do people *really* behave, given constraints on their information, learning, remembering and reasoning capacities?

Recent Nobel Prizes recognize this two-track evolution. Nobel Prizes were awarded to Simon, in 1959, for bounded rationality, Selten, Harsanyi and Nash (1994) for game theory contributions, Merton and Scholes (1997) for quantifying and pricing contingent assets, Akerlof, Spencer and Stiglitz (2001) for analyzing markets when some people know more than others, and finally, Kahneman (2002) for “having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty.”

Economics is frequently mocked when successive Nobel Prizes are awarded to scholars whose key findings directly contradict one another. I believe economics’ ability to accept, and even harness, intellectual cognitive dissonance is not laughable but in fact a source of vitality and strength.

### 3. The foibles of rationality: the psychology of prediction

... people predict the outcome that appears more representative of the evidence.

Kahneman and Tversky (1973, p. 237)

<sup>2</sup> It is interesting to speculate what von Neumann’s expected-utility theory would have been like, had he built it after publication of “prospect theory” in Kahneman and Tversky (1979).

We think in the abstract, but live in the concrete.

Alfred North Whitehead

This paper (Kahneman and Tversky, 1973), published 30 years ago, is Kahneman's personal favorite of all his published papers,<sup>3</sup> and it is mine too. To truly understand how the direct-observation methods of psychology have revolutionized economic thinking, it is enough to pore over this paper alone. Like all good behavioral research, it began with a keen-eyed observation—and led to pathbreaking research.

As colleagues at the Hebrew University in 1968, Tversky and Kahneman taught Israeli Air Force flight instructors. They were fascinated by how the instructors used rewards and punishments to motivate their pilot-trainees. The instructors refuted psychologists' stock-in-trade, that reward is far more powerful than punishment. They claimed the policy got bad results, because in their experience "... good execution of complex maneuvers (reinforced by reward) typically results in a decrement of performance on the next try" (ibid., p. 251).

How would a psychologist respond? The answer to the riddle lies in the concept of "regression toward the mean." Regression is inevitable in flight maneuvers, Kahneman and Tversky observe, because performance is not perfectly reliable and progress between successive maneuvers is slow. Hence, it was likely that pilots who did well on one trial will deteriorate on the next. Flight instructors wrongly attributed this 'regression' to the detrimental effect of their positive reinforcement. The concept of regression is "counterintuitive and difficult to apply," they note. The reason: "regression effects typically violate the intuition that the *predicted outcome should be maximally representative of the input information.*"

Kahneman and Tversky's research on 'representativeness' is an example of a human foible known as "attribution" error—attributing outcomes to the impact of "inputs"—human action and intervention, rather than to the randomness of life, a "saddening aspect of the human condition," they note. It is saddening, because a wrong theory creates a self-reinforcing feedback loop that ultimately hardens belief in that theory into fixed certainty, does damage and is difficult to alter.<sup>4</sup> By simple regression toward the mean, we see behavior worsen after reward, and improve after punishment, and come to believe in a false causal relation: Punishment works, reward doesn't. Armies of school psychologists are needed to repair the devastation this misanthropy causes.

Few people are able and willing to admit that more often than not, the world is aleatoric and throws dice. Sometimes, expertise reinforces, rather than weakens, this bias. In many experiments, including those in "On the Psychology of Prediction," Kahneman and Tversky used subjects expert in probability, psychology or statistics. They show that judgment biases

<sup>3</sup> Email from Kahneman, in response to my question.

<sup>4</sup> Some wrong perceived theories *improve* the human condition. The Black–Scholes option-pricing formula may be an example. A solution to a partial differential equation, the formula is based on untrue assumptions. Yet because option traders universally believe in, and use, this formula, the correlation between most option prices and the theoretical formula is perfect—a case in which perception truly creates reality. It is doubtful that the huge market for derivatives would have developed *in the absence* of the Black–Scholes formula; with no pricing benchmark, option trading would have lacked a coherent standard of value that buyers and sellers could each accept.

and heuristics are rarely mitigated by education or experience—as is the case with the pair choice that began this essay.<sup>5</sup>

Many biases are human efforts to escape, or deny, the implications of randomness. I once enlisted a group of Ivy League colleague students who had completed a finance course that included ‘efficient markets’ random-walk theory (“stock price changes carry no information”). They were given a week to study (random) price data for a group of fictitious stocks. A stock market was then simulated, where each participant bought and sold various stocks in response to (still random) price movements (Maital et al., 1986). In the debriefing, participants consistently misinterpreted random price movements as informative, systematic trends that generated strong buying and selling on their part.

In the same vein, in 1985 Tversky and two colleagues refuted the ‘hot hand’ theory in basketball—the notion, an article of faith among players and fans alike, that players “get hot,” i.e. hit a string of shots much longer than their overall shooting percentage. *Random* “hot hands” are inevitable, just as a run of 20 straight “seven’s” is certain if you toss dice long enough. The point is, they are random, hence, can’t be used by coaches or players to win games. Yet, stocks, dice, baskets, whatever, despite all evidence, we believe firmly in cause-and-effect. Reason and action underlie randomness, we believe—though the phrase itself is an internal contradiction.

While “... Prediction” may be his favorite paper, Kahneman agrees that “Prospect Theory” (Kahneman and Tversky, 1979) is his most influential one. It is by far the most cited paper of all those published in *Econometrica*. By axiomatizing the heuristics and biases they discovered, Kahneman and Tversky revealed their deep understanding of the economist’s mind and the mechanics of scientific revolutions. By speaking to mainstream economists in their language, in the economics journal most single-mindedly focused on mathematical reasoning, they won converts and adherents who would not have become believers solely by reading, or ignoring, articles in *Journal of Experimental Psychology*. Prospect theory has now found wide use in many disciplines. To cite only one example, Fiegenbaum (1990) has shown that companies evince risk *affinity* by increasing risk and debt (rather than decreasing them) when losses mount. The result: In the loss domain, the risk-return curve has a negative slope—perhaps a partial explanation for today’s wave of huge bankruptcies.

We do sometimes think in the abstract, as Whitehead noted. But more often than not, because we are human, we *think* as well as live in the concrete. The results are sometimes amusing, sometimes tragic. This is the powerful message of *The Psychology of Prediction*.

Rather than plod through the diverse and creative set of findings in which Kahneman exposed the foibles of Economic Person, let us instead peak at the diary of Rational-Man Stan.

The day is December 10, 2002.

#### 4. The diary of “Rational-Man Stan”: December 10, 2002

6 a.m. Trundled the garbage cans out front; collection day today. Neighbor yelled at me for waking her; clearly, this is going to be a bad day. “(people have) undue confidence

<sup>5</sup> With a Princeton University student, I once examined Tversky–Kahneman decision biases among the most risk-savvy group we could find: pit bosses at a gambling casino. They exhibited the same biases as ordinary people. See Maital and Paolucci (1990).

in early trends, e.g., the data of the first few subjects,” Tversky and Kahneman (1971, p. 109).

6:30 a.m. Woke Jordie for school. Grounded her for coming home an hour late last night. Leniency doesn’t pay; gave her extra time at friends in return for good grades, and she still got in late. “We normally reinforce others when their behavior is good and punish them when their behavior is bad. By regression alone, therefore, they are most likely to improve after being punished and most likely to deteriorate after being rewarded. Consequently, we are exposed to a lifetime schedule in which we are most often rewarded for punishing others, and punished for rewarding” Kahneman and Tversky (1973, p. 251).

6:40 a.m. Mark said he’s trying out for varsity lacrosse today. I am quite certain the kid is either going to star, or be cut from the team in a week. “Subjects predict outstandingly high achievement with very high confidence, and they have more confidence in the prediction of utter failure than of mediocre performance . . . factors which enhance confidence [consistency, extremity] are often negatively correlated with predictive accuracy” Kahneman and Tversky (1995, p. 249).

12 noon. Saw my cardiologist. He recommended triple bypass surgery. “3% chance you’ll die on the table,” he said. I declined. No way. But when he pointed out I had fully a 97% of surviving—97 out of 100 of his patients made it—I said sure, OK; I would be one of the 97. “The same decision can be framed in several different ways; different frames can lead to different decisions” Kahneman and Tversky (1982, p. 139); “alternate descriptions of a decision problem give rise to different preferences” Tversky and Kahneman (1991, p. 143).

1 p.m. Met with my investment advisor. Despite the ‘down’ market, I’m way ahead this year. Funny. I know I’m a lot richer. But I don’t feel any happier or better off than last year. “. . . experienced utility is potentially measurable” Kahneman (2000, p. 673).

3 p.m. Board meeting. I presented our quarterly forecast. I’m very upbeat. Things look good. But—I’m proposing we close the Widget II project. We have other eggs in our basket. “. . . forecasts of future outcomes are often anchored on plans and scenarios of success . . . and are therefore overly optimistic; . . . evaluation of single risky prospects neglect the possibilities of pooling risks and are therefore overly timid” Kahneman and Lovallo (1993, p. 17).

4 p.m. Met with my marketing VP. There is high demand for our new digital Widgets. But we decided it would be unfair to hike prices, to exploit it. “. . . it is [considered] acceptable for a firm to raise prices when profits are threatened . . . but . . . unfair to exploit shifts in demand by raising prices” Kahneman et al. (1986, p. 128).

5 p.m. Met with my CFO. Last year we hedged our yen revenues with long yen put options and are deep in the red. Told him to hang on—yen could turn around sharply any day. “most people have a risk-seeking preference for the gamble over the sure loss” Kahneman and Tversky (1982, p. 13); “losses have greater impact on preferences than gains” Tversky and Kahneman (1991, p. 143).

5:35 p.m. Took the stairs down to the parking garage, instead of the elevator. Elevators are risky. OK, I know—last time someone was trapped in the elevator was eight years ago; but—you never know, no-one ever got trapped in a staircase! “People overweight outcomes that are certain, relative to outcomes that are merely probable” Kahneman and Tversky (1979, p. 265).

5:40 p.m. Bought a lottery ticket at a kiosk. Prize is \$50 million. Long queues; I guess they’ll sell a few million tickets. But—my chances are as good as anyone’s. “low

probabilities are commonly overweighted” Kahneman and Tversky (1982, p. 138); also Kahneman and Tversky (1979).

6 p.m. Drive home. Maybe I should fasten my seat belt; last time I didn’t, it cost me a \$400 fine. “there is a case for ‘paternalistic interventions’ . . . it is plausible that the state knows more about an individual’s future tastes than the individual knows presently.” Kahneman (1994, pp. 758, 760).

9 p.m. Econ 101 class at Silicon State, trying at last to finish my B.A. degree. Instructor explained how rational people always maximize their expected utility. Hey! That’s me all right!

11 p.m. Dozed and watched the late news. A psychologist named Kahneman in a tuxedo was awarded the Nobel Prize in Economics for some research he did on non-rationality.

Those economics professors. Nothing they research has any relevance for me and my life. Wait . . . did they say—a psychologist???

## 5. The future of rationality

reason, n. 3. the ability to think, form judgments, draw conclusions, etc. 4. sound thought or judgment; good sense.

rational, n. 3. *showing reason; not foolish or silly; sensible;*

[SYN ... *implies the ability to reason logically, as by drawing conclusions from inferences, and often connotes the absence of motionalism; . . . reasonableness . . . suggests the use of practical reason in making decisions, choices, etc.*]

Webster’s New World Dictionary

People are, for the most part, reasonable, in the ordinary Webster’s Dictionary sense. Facing enormous complexity, with limited cognitive resources, time and energy, and in an increasingly uncertain world, they do as well as they can. People are not rational, in the axiomatic expected-utility sense. But—does it really matter?

The American humorist James Thurber once said in a serious moment that it is more important to know some of the questions than to know all of the answers. Perhaps the key question is not, are we rational, but rather what is it about our judgments that keep us from achieving our desired goals? Why are people less well off than they could and should be? Given human behavior, as it really is—how can the human condition be improved?

Addressing the issue of rationality, Kahneman (1994) wrote: “The time has perhaps come to set aside the overly general question of whether or not people are rational, . . . allowing research to be focused on more specific and more promising issues.” He suggests that we ask instead: “what are the most important ways in which people fail to maximize their outcomes?” And, how can this be changed?

One focus of behavioral economics is complexity and the human need to simplify. Confronting a complex, uncertain world, people look for ways to distill masses of information into understandable bites, to make uncertain less so, to make complexity more simple, and to conserve the increasingly scarce cognitive resources on which a complex world places heavy demands on. Who is to say that the Kahneman–Tversky heuristics are irrational, if they in general serve our needs well, or at least well enough? Outcomes, Kahneman observes, not assumptions, should be the acid test of what is regarded as rational or reasonable.



## 6. Conclusion

You cannot solve a problem with the same level of thinking that created it.

Albert Einstein (Calaprice, 2000, p. 317)

Amos Tversky once remarked that he merely examined in a scientific way things about behavior that were already known to advertisers and used-car salesmen.<sup>6</sup> Daniel Kahneman would agree. By returning to Marshall's mandate and exploring how people live and move and think in the ordinary business of life, Daniel Kahneman has powerfully illuminated the human condition. He and Amos Tversky have revealed a broad array of human foibles. Their work seems to me a kind of scientific extension of Balzac's *Human Comedy*. By seeing ourselves as we really are, we are far more able to become what we hope and want to be, as individuals and as societies. Collectively, as a state, we may be better equipped to perceive our future needs than can any single individual (Kahneman, 1994).

With the fall of the Berlin Wall on November 9, 1989, the principle of free markets fostered by economics is now globally accepted, with few exceptions, as the central organizing principle of society. This is a major revolution. Like all revolutions, it is accompanied by crises, stresses and social fractures. Just when these byproducts seem enormously threatening to world stability, behavioral economics brings to the table a set of findings that can modify, mitigate and humanize the free-market principle.

In shaping the research agenda of economics for the next decade, Kahneman is right. It is time to shelve the futile debate over rationality. Instead, we should focus on results—on how well individuals, and society, are doing, why we are doing well in some cases and very badly in others, and given our 'foibles,' how we might do better. Once this focus is embraced, the policy-driven moral dimension of economics is reborn. We return to where economics began—not in *Wealth of Nations* (1776) but in *Theory of Moral Sentiments* (1759) (Dougherty, 2002). A new level of thinking in economics is truly needed. And Nobel Laureate Daniel Kahneman, cognitive experimental psychologist, perhaps more than anyone, has provided it.

## 7. Postscript

No discussion of Daniel Kahneman's work would be complete without mentioning his close friend, colleague and fellow Israeli Amos Tversky. Tversky died of metastatic melanoma on June 2, 1996, at the age of 59, just 6 years before Kahneman's Nobel was announced. "The prize is quite explicitly for joint work," Kahneman said at the time, "but unfortunately there is no posthumous prize."

Kahneman and Tversky began their 30-year collaboration at the Hebrew University in the 1960s. Tversky's widow Barbara, a Stanford University psychology professor, described their collaboration in these words: "It was an amazing synergistic collaboration. They spent

<sup>6</sup> Karen Freeman, Amos Tversky, Cognitive Psychologist, at 59. New York Times, June 6, 1996. (Web site). For economics students who want to know how consumers *really* behave, I refer them to marketing journals—a neighborhood regarded by economists, for the most part, as disreputable, to be studiously avoided or frequented only in secret.

hours talking on the phone every week. They wrote every word together. It was a real intellectual high to watch them.”<sup>7</sup>

Daniel Kahneman’s list of publications includes 27 publications with Tversky as a co-author and 24 with Tversky as sole co-author. Of the 24, 11 are listed with Tversky as first author, 13 with Kahneman as first author. Neither Kahneman nor Tversky would attach any significance to the order of authorship, so close was their relationship.

A memorial resolution passed by the Stanford University Senate noted: “Through a combination of carefully wrought experiments, elegant formalizations and an uncanny ability to draw upon everyday experience, [Tversky and Kahneman] offered compelling accounts of processes and shortcomings that characterize human judgment and decision making.”

Tversky was a brilliant, prolific scholar. His contributions in psychology ranged from the foundations of measurement, to similarity assessment and misperception of randomness. In one of his famous papers, he showed that the widely-held belief National Basketball Association players at times have “hot hand” streaks, when their odds of sinking successive baskets are higher than at other times, is false; successive ‘hits’ and ‘misses’ by NBA players are random. In his last months, he finished *Choices, Values and Frames* (2000), the volume co-edited with Kahneman. As befits the scholar who with Kahneman explored ‘framing’ (Tversky and Kahneman, 1986), towards the end of his life he “helped [his friends and colleagues] ‘frame’ his 59 years, not as a tragically shortened life but as a wonderfully fulfilling and complete life . . . albeit tragically shortened.”<sup>8</sup> An article in *Psychological Science* succinctly summarized this point: The research program initiated by Kahneman and Tversky is considered psychology’s “leading intellectual export to the wider academic world.”

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<sup>7</sup> “Nobel winner cites work of collaborator, Amos Tvesky”, by Lisa Trei. Stanford Report, October 16, 2002.

<sup>8</sup> Stanford University Faculty Senate Memorial Resolution.

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