

1 **Theoretical Behaviorism,**
2 **Economic Theory, and Choice**

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4 John Staddon
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16 Psychology is not a single science. There are—alas—many psychologies.
17 Behaviorism is one of them, and “theoretical” is one kind of behaviorism.¹
18 Economics also is far from unified. To understand the relation between
19 psychology and economics, it might be best to begin with one psychology
20 and one economics, rather than attempt a review of two highly various
21 fields. I compare two ways to look at choice behavior: *theoretical behav-*
22 *iorism* and *prospect theory*, a popular approach to behavioral economics
23 as it has been presented in Daniel Kahneman and Amos Tversky’s semi-
24 nal 1979 paper and later writings.

25 What is *choice*? Charles Darwin wrote copious notes, two months
26 before his engagement to his cousin Emma Wedgwood, listing the pros
27 and cons of marriage.² A sample:

28 *Marry* [pros]:
29 Children—(if it Please God)—Constant companion,
30 (& friend in old age) who will feel interested in one,—
31

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35 conference.

36 1. For a review of the behaviorisms, see Staddon 2014a. For one attempt to apply theoretical
37 behaviorism to the financial system, see Staddon 2012. An early effort to bring together psy-
38 chology, biology, and economics is a collection of papers in Staddon 1980.

39 2. See www.darwinproject.ac.uk/darwins-notes-on-marriage.

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object to be beloved & played with.—better than a
 dog anyhow.—Home, & someone to take care of
 house—Charms of music & female chit-chat.—These
 things good for one's health.—but *terrible loss of*
 time . . .

Not Marry [cons]: Freedom to go where one liked—choice of Society
 & little of it.—Conversation of clever men at clubs—
 Not forced to visit relatives, & to bend in every
 trifle.—to have the expense & anxiety of children—
 perhaps quarrelling—Loss of time.—cannot read in
 the Evenings—fatness & idleness . . .

There is much more, but you get the idea. This is choice indeed! No one
 would imagine that animals choose like this. Indeed, they do not, and for
 the most part, people do not either. So, I begin with the simplest possible
 choice situation. The two-armed bandit is popular not just in Las Vegas
 but among operant conditioners, those who study learned instrumental
 behavior. The subjects are usually animals—more easily, and ethically,
 subjected to experimental conditions than human beings and probably
 easier to understand. Pigeons and rats often seem to follow elementary
 economics. They are *rational*, in the sense that they maximize the rate of
 reward. For example, a hungry pigeon in a Skinner box randomly paid off
 on average for one in every ten pecks (termed a *random-ratio* schedule)
 on a response key on the left and on average for one in every five pecks for
 pecking on the right—such a pigeon will soon peck only on the right. It
maximizes.

Indeed, optimality theory can explain many characteristics of the oper-
 ant behavior of animals, of the ways they adapt to different kinds of *rein-*
forcement schedules. But animals also fail to act rationally, even in some
 strikingly simple situations.³ The failures are more interesting than the
 successes. Sticking with ratio schedules, consider a *fixed-ratio* schedule
 that requires exactly one hundred pecks for each food reward. A pigeon
 will soon learn to get food this way. But he will always wait a second or
 two after each reward before beginning to peck, thus delaying food deliv-
 ery unnecessarily. Fatigue? No; on a comparable *random* ratio, he will
 respond steadily, not waiting after food.

3. See, e.g., Staddon 2007 and references therein. For a comprehensive treatment, see Stad-
 don 2016.

1 The reason he waits is that he has a built-in, automatic timing mecha-
2 nism that responds to the minimum time between food deliveries enforced
3 by the fixed (but not the random) ratio by pausing after each food. It is
4 easy to show this by comparing two kinds of time-based schedules. Sup-
5 pose you start a sixty-second timer after each food delivery and do not
6 reward a peck until sixty seconds have passed (a fixed-interval schedule).
7 As you might expect, once the animal has learned, he waits perhaps thirty
8 seconds after each reward before beginning to peck. If his time sense
9 were perfect, no variability, he would presumably wait exactly sixty sec-
10 onds so as not to waste pecks. The pigeon's timing is a bit variable, so he
11 usually starts early. Perfectly rational: do not waste pecks, but do not delay
12 food unnecessarily. Now suppose you modify the procedure slightly by
13 starting the sixty-second timer only after the first peck. The rational adap-
14 tation is simple: respond immediately after food, and then wait as before.
15 But animals do not do this. If the interval duration is T seconds and the
16 typical wait time is $T/2$, then on this response-initiated-delay schedule
17 they will wait not $T/2$ but T seconds, delaying reward quite unnecessarily.

18 The message: optimality theory is of limited use in understanding what
19 these animals are doing. Animals never, and humans almost never, are
20 *explicit maximizers*, computing marginals and choosing accordingly, as in
21 some interpretations of rationality. They adapt via built-in processes, like
22 timing, that sometimes yield "rational" behavior and sometimes do not.
23 Behavioral ecologists call them "rules of thumb" or (a familiar term to
24 decision theorists) heuristics.

25 The time dimension adds complexity, and the way in which time is
26 incorporated into learned behavior is still not perfectly understood. So, let
27 us stick with random-ratio schedules, where time is irrelevant. A choice
28 situation where there is no rational strategy or, to put it a little differently,
29 all strategies are rational is choice between two *identical* random ratios.
30 What do pigeons do and how might theoretical behaviorism explain it?
31 The explanation follows the Darwinian consensus: instrumental learning
32 is selection and variation. There is a repertoire of response tendencies—
33 candidates. Candidates could be simple responses, heuristics, or what Gerd
34 Gigerenzer calls an "adaptive toolbox" (Gigerenzer and Selten 2001). But
35 only one response occurs at a time. In the example I am about to give,
36 these candidates compete in a nonlinear, winner-take-all way, so that only
37 the strongest tendency, the *active* response occurs. The other responses
38 are *silent*—like recessive genes. The active response is either strength-
39 ened (if it is followed by reward) or diminishes in strength (if there is no

reward). Notice that the variation-selection approach allows for individual differences. Different people will come to a given situation with different repertoires and different active responses.

Many dynamic processes have been proposed to describe how response strength increases after reward and decreases after nonreward. The one we have found that best combines simplicity and generality incorporates the organism's history of both reward and responding. It is not the last word.⁴ Nevertheless, it shows how a simple moment-by-moment process can yield complex and often adaptive behavior. I show later that prospect theory, although not a theory in the same sense as the CE model—it is classification of the data, not a predictive model—nevertheless implies a similar underlying framework.

The assumptions of the *cumulative effects (CE) model* are as follows:

1. In a given choice situation, there is a repertoire of *candidates* (responses).
2. Each response has a certain *strength*, which is given by the following, equation 1:

$$X_i = \frac{\sum R_i + R_i(0)}{\sum x_i + x_i(0)}$$

where X_i is the strength of response i , R_i , and x_i are the rewards received and i -responses made; $R_i(0)$ and $x_i(0)$ are initial conditions. In words, the strength of each response tendency is just the cumulated payoff probability for that response, biased by prior reward and response totals. The learning rule is very simple: a response not followed by reward increases the denominator and thus reduces X_i ; a reward increments the numerator proportionately more than the denominator and thus increases X_i .

3. Response tendencies compete to become active in winner-take-all fashion.

This simple model behaves rationally in choosing between two options that pay off with different probabilities: it will eventually fixate on the higher-probability choice.

More surprising is that it can duplicate pigeons' performance on successive-reversal learning (Davis et al. 1993; Staddon 2014b). In these

4. For one thing, it is deterministic, not stochastic. The randomness in my example is provided by the schedule. On fixed-ratio schedules, the result is usually indifference, which is probably not correct—although the necessary experiment does not seem to have been done.

1 experiments the pigeon chooses between two keys, as in the previous
 2 example. On day 1, pecks on the left key (say) are paid off randomly with
 3 probability 1/8; the right key is not paid off. On day 2, this is reversed:
 4 right $p(\text{reward}) = 1/8$, left $p(\text{reward}) = 0$.

5 And so on for many days: left and right rewarded on alternate days.

6 Unsurprisingly perhaps, pigeons improve over days, switching their
 7 preference faster and faster each day. This is called “reversal learning set,”
 8 and many cognitive explanations have been offered for it. But the CE
 9 model can duplicate the effect because, over successive reversal days, the
 10 X values of the two choices get closer and closer so that switching from
 11 one to the other (because of the winner-take-all rule) gets faster and faster.
 12 No need to postulate a “set” or anything beyond simple learning.⁵ The
 13 same model also predicts, correctly, that reversal performance will
 14 improve less if reversals take place every four days rather than every day.

15 So what does the CE model (and many models like it) predict should
 16 happen when the animal must choose between two *identical* ratio sched-
 17 ules? Maximization makes no prediction because the animal’s choice has
 18 no effect on payoff. A version of H. A. Simon’s satisficing⁶ might predict
 19 random fixation on one side, given that switching entails some small cost,
 20 but that is not what happens.

21 Figure 1 shows a simulation of the CE model in this situation and some
 22 data (Horner and Staddon 1987).⁷ The model predicts, and the data show,
 23 that the animal’s behavior depends on the absolute value of the payoff
 24 probability. If it is high, the animal tends to fixate (randomly) on one or
 25 other choice; if it is low, it tends toward indifference.

26 Gordon Tullock (1971), who was one of the first economists to look at
 27 biological problems from an economic viewpoint, proposed something
 28 like this in his nifty little note “The Coal Tit as a Careful Shopper”:
 29 “Assume that the bird, like any other food-consuming animal, explores a
 30 number of different food sources [pine cones with grubs, in this case], and
 31 then settles on the one which provides the most food with the least energy
 32 expended. Since it would tend to exhaust the food supplies in that particu-
 33 lar area, it should be ‘programmed’ in such a way that it periodically inves-
 34 tigate different areas.” The CE model adds dynamics plus the prediction
 35 that the bird turns sooner to “periodical investigation” when it pecks a
 36

37 5. Pigeons never show *spontaneous reversal*—switching on the first response each day.
 38 They always require a few unsuccessful responses to yesterday’s “hot” key before switching.

39 6. See en.wikipedia.org/wiki/Satisficing.

40 7. For an extensive theoretical analysis of this and related situations, see Staddon 1988.

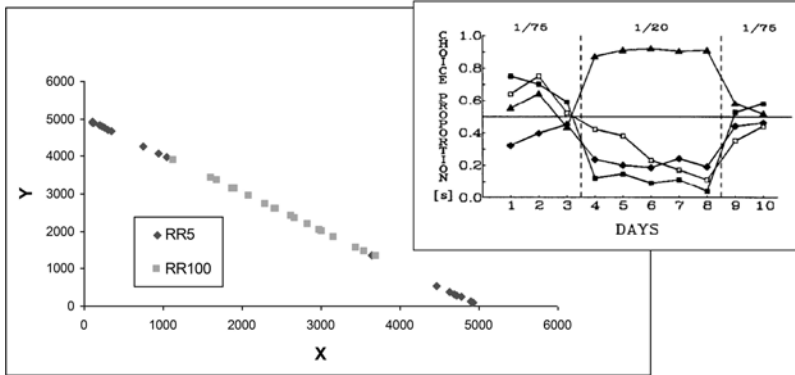


Figure 1 The pattern of choice between identical schedules as a function of absolute reinforcement rate *Note:* CE model simulation: Two identical random ratios, 5 and 100. Preferences after twenty runs each of 4,993 time steps. Graph plots total responses: X vs. Y for two ratios: 5 and 100. Exclusive choice is favored at the smaller ratio (diamonds), indifference at the large value (squares). Initial values in Equation 1: $R_L = R_R = 5$, $x = y = 10$. Data: The figure plots the proportion of choices of the righthand alternative across daily sessions for each of four pigeons for two equal-random-ratio conditions, $p = 1/75$ and $p = 1/20$, in ABA sequence (Horner and Staddon 1987, fig. 1). In both simulation and data, exclusive choice is favored at the high probability, indifference at the low.

relatively grub-free pine cone. This in outline is how one theoretical school of psychology thinks about the processes that underlie choice. How does prospect theory treat problems like this?

Human Choice

Animals must actually experience the different payoffs to arrive at a stable preference. Not so for people: you can just ask them (Kahneman 2011).⁸ Consequently, the study of human choice behavior has developed along very different lines from the study of choice in animals. Nevertheless, I show that both can be conceived in a similar way.

8. But of course what they do when they actually experience outcomes may be very different from what they say in advance they will do. See, e.g., Ludvig, Madan, and Spetch 2014. Portions of this section, by the way, appear in Staddon 2016.

1 The study of human choice differs from animal choice in four main ways:

- 2 1. People begin with a stock of *wealth*. There is no real equivalent in
3 animal experiments.⁹
- 4 2. There is no animal equivalent to *loss*.
- 5 3. Individual differences: *There is rarely unanimity in choice experi-*
6 *ments with people*. Even when there is a statistically significant
7 preference, 30–40 percent of subjects may deviate from the major-
8 ity choice. In most animal choice experiments the effects are
9 reversible (see figure 1), so the result can be replicated with the
10 same subjects and no statistics are required. In practice, close to
11 100 percent of subjects give the same result.
- 12 4. Human choice patterns can be changed by experience: risk aver-
13 sion can be changed to risk seeking by appropriate training or
14 prompting,¹⁰ for example. In most animal studies, choice is stable.

15 Because people will give immediate answers to many hypothetical choice
16 questions, and because their decisions can often be accurately anticipated,
17 hypotheses can be tested quickly. This strategy was adopted by two of the
18 leaders in this field, Daniel Kahneman and the late Amos Tversky. They
19 posed questions to themselves, and based on their own answers (which
20 were later checked with groups of human subjects), they quickly found
21 flaws in *utility theory*, the standard explanation in economics.

24 Prospect Theory

25 Daniel Bernoulli in the eighteenth century pointed out that the utility of a
26 given increment in wealth is inversely related to the amount of wealth you
27 already have. A hundred dollars is worth much more to a pauper (net
28 wealth: \$5) than to a millionaire.¹¹ Anticipating a now well-known prin-
29 ciple in psychophysics, the Weber-Fechner law, Bernoulli proposed that
30 the relationship between wealth and utility is logarithmic, so that equal
31 ratios correspond to equal value. A pay raise of \$1,000 is worth as much

33 9. One experiment has tried, with some success, to induce monkeys to treat a stock of
34 tokens as wealth: see Lakshminarayanan, Chen, and Santos 2011. This effect fits in with the
35 more general analysis I present here, but it does suggest that monkeys are smarter than pigeons.

36 10. Experienced traders show fewer biases than novices; for example, see Kahneman 2011.

37 11. Comparing utility between individuals is epistemologically flawed, of course, even
38 though it is the basis for the idea of social justice. We can verify that person A prefers X to Y
39 and person B the reverse. We cannot say whether A values X more than B does. After all, the
millionaire may be one just because he values a dollar, any dollar, more than does the pauper.
Bernoulli's assumption is verifiable for individual utility but not for interpersonal comparison.

to an employee whose base pay is \$10,000 as a raise of \$10,000 to one who makes \$100,000.

The standard utility function is negatively accelerated, which means diminishing marginal utility. Because each increment of value adds a smaller increment of utility, people will generally be *risk averse* with respect to gains because doubling a reward less than doubles its utility. For example, in a typical experiment (Problem 3 in Kahneman and Tversky 1979),¹² ninety-five people were asked to choose between two outcomes: 4,000 with probability 0.8, versus 3,000 for sure. Eighty percent chose the sure thing, even though it is less than the expected value of the gamble: $3,000 < 3,200$. Apparently, 0.8 times the utility of 4,000 is less than the utility of 3,000, $0.8 \times U(4,000) < U(3,000)$, because the utility function is negatively accelerated.

Yet expected value alone explains Problem 4, where 65 percent of the same ninety-five people preferred a 0.2 chance of 4,000 to a 0.25 chance of 3,000: in expected values, 800 was now preferred to 750—no sign of diminishing returns there. Evidently *certainty* has an effect that goes beyond the probability of one.

There is another way to look at Problem 3. The “3,000 for sure” option is guaranteed. It increments your current state of wealth, *unless* you choose the risky option, in which case, with probability 0.2 (the chance you *do not* win the 4,000), your wealth could go down by 3,000, a *loss*. So the issue becomes the following: is $0.2 \times U(-3,000) > U(4,000 - 3,000)$, that is, is 0.2 times the cost of losing 3,000 (i.e., actual expected value 600), greater than the benefit of a net gain of 1,000? And the answer is yes if the origin of the utility curve is shifted up by 3,000 on the utility axis (i.e., 3,000 is subtracted from each utility). In this case the disutility of a loss of 600 is greater than the utility of a gain of 1,000. But such a shift requires a further assumption about how people *perceive* a choice situation. The shift of origin is not really required for Problem 3, since the all-positive utility curve works as well, but it is necessary to account for other results.

Data like these led Kahneman and Tversky to propose *prospect theory* as a replacement for standard utility theory. Prospect theory is a hybrid. The “front end” is what they term *editing*: “Prospect theory distinguishes two phases in the choice process: an early phase of editing and a

12. The example is Problem 3; amounts are in Israeli currency. This version of prospect theory was elaborated in Tversky and Kahneman 1992, and there is a vast secondary literature. See also Kahneman’s readable book *Thinking Fast and Slow* (2011) and his Nobel Prize address: www.nobelprize.org/mediaplayer/?id=531.

1 subsequent phase of evaluation” (Kahneman and Tversky 1979, 274).
 2 Editing is their name for cognitive processes that set up the problem for
 3 the *evaluation* part of the theory. Editing is a process, but it is not defined
 4 in any calculable way. Terms such as framing, combination, segregation,
 5 isolation, coalescing, and cancellation have been used to label operations
 6 that the decision maker can use to simplify and structure the choice prob-
 7 lem so that it can be evaluated. Exactly when these processes are invoked
 8 and precisely how they work are not specified by any economic theory.

9 The core of prospect theory is the second phase: *evaluation*, which is a
 10 modified version of expected utility theory. Evaluation is a teleological/
 11 functional theory; it describes an outcome but not the process the system
 12 uses to achieve it. Evaluation, according to prospect theory, modifies util-
 13 ity theory in three ways:

- 14 1. The idea of a *reference point* or adaptation level, which is set by the
 15 subject’s current state of wealth.¹³ The reference point moves the ori-
 16 gin of the utility curve to a point representing the subject’s current
 17 wealth. A choice option that yields a state of wealth less than the
 18 reference point is perceived as a loss. The idea that people are sensi-
 19 tive to changes rather than absolute values is a core principle of per-
 20 ceptual psychology.
- 21 2. Thus, the upper-right quadrant of the utility graph is the same as
 22 before. But the lower left part is modified, to deal with the following
 23 results involving losses. There are three steps; the last two require
 24 changes in the standard form. First, most people will choose a 50
 25 percent chance of losing \$100 only if the other possibility is a win of
 26 \$200 or more: “People tend to be risk averse in the domain of gains
 27 and risk seeking in the domain of losses” (Kahneman 2011, 344).
 28 Thus, the first part of the southwest quadrant must be steeper than
 29 the first part of the northeast. This requires no big change in the
 30 shape of the standard Bernoulli utility graph, which gets steeper as it
 31 approaches the origin.
- 32 *But*, second, 65 percent of subjects preferred a 0.2 chance of winning
 33 4,000 over a 0.25 chance to win 3,000 (expected values: $800 > 750$;
 34 Problem 4), that is, they were in line with expected value theory and
 35 not risk averse. So the curve must straighten out at intermediate prob-
 36 abilities. And finally, 86 percent of people preferred a 0.9 chance to
 37 win 3,000 over a 0.45 chance to win 6,000 (Problem 7), even though
 38

39 13. See also Markowitz 1952.

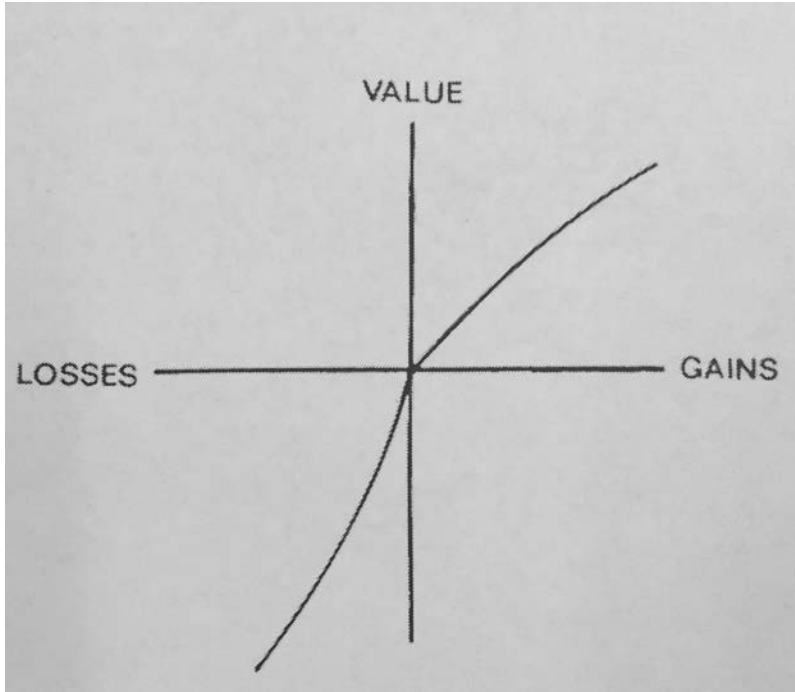


Figure 2 Prospect theory utility function

both gambles have the same expected value. Now subjects showed risk aversion. Hence the curve in the southwest quadrant must begin steep, then straighten, and then flatten out. This is the iconic prospect theory utility graph (see figure 2: Kahneman and Tversky 1979, fig. 3).

3. Gambles at extreme odds do not fit even this modified utility graph. For example, 73 percent of people prefer a .001 chance to win 6,000 over a .002 chance to win 3,000 (Problem 8), even though the expected values are the same, that is, back to risk seeking.

Another exception is provided by something called probabilistic insurance. Suppose that you are indifferent about whether or not to insure your house against earthquakes. A creative salesman then makes you this offer: we are willing to insure you for just 45 percent of the original premium if we are allowed to toss a coin after an incident to decide whether we pay you or just refund your premium. Obviously this is a better deal than the original one, which you were on the point of accepting. Yet people will

1 usually reject it. Not that they are against probabilistic insurance on prin-
 2 ciple. As Kahneman and Tversky point out, the decision to quit a risky
 3 habit like smoking is a form of probabilistic insurance.

4 These problems cannot be solved through changes in the utility curve
 5 alone. To fix them, Kahneman and Tversky (1979, fig. 4) introduce a some-
 6 what untidy transformation of probabilities (“ π is not well-behaved near the
 7 end-points”), termed *decision weights*, that parallels Bernoulli’s transfor-
 8 mation of value. Evidently both the utility curve and the probabilities must
 9 be transformed to accommodate data.

11 **A Common Framework**

13 Attempts to quantify all these modifications require four or even five fit-
 14 ted parameters.¹⁴ That is just too many for a useful scientific theory. John
 15 von Neumann, genius, computer pioneer, and coinventor of game theory,
 16 famously remarked: “With four parameters I can fit an elephant, and with
 17 five I can make him wiggle his trunk.” Prospect theory has evolved into a
 18 set of descriptions, not a predictive system. Nevertheless, as I will show,
 19 the underlying concepts can be related in an interesting way to choice in
 20 nonhuman animals.

21 Human choice behavior is affected by many things: not just the num-
 22 bers you are presented with but your state of wealth; your experience, both
 23 recent and historical; the kind of goods on offer—money or things, for
 24 example—the context in which the task is presented; and your willing-
 25 ness to think through the options.

26 Kahneman and Tversky tackle this complexity by pointing out that
 27 prospect theory deals only with decisions that are made quickly. They
 28 distinguish between fast and slow cognitive processing,¹⁵ what Kahneman
 29 calls System 1 (fast, thoughtless) and System 2 (slow, reflective). Presum-
 30 ably, the rapid process is simpler to understand than the slow one.

31 Their scheme is not as different from the analysis of animal choice
 32 behavior that I presented earlier as you might think. Consider three
 33 aspects of prospect theory: the role of consciousness, framing, and the
 34 fast-slow distinction.

35
 36 14. See, e.g., Wilkinson and Klaes 2012, 163.

37 15. I think that the fast-slow distinction is actually due to Kahneman, but because Tversky
 38 would probably have agreed had he lived, and because prospect theory is identified with both of
 39 them, I use both names.

Prospect theory is usually considered a cognitive, as opposed to a behavioristic, system. Yet the role of consciousness, especially in the fast system, is minimal: “The mental work that produces impressions, intuitions, and many decisions goes on in silence in our mind”; and “Studies of priming effects have yielded discoveries that threaten our self-image as conscious and autonomous authors of our judgments and our choices” (Kahneman 2011, 4, 55). Compare this with the following comment by a behaviorist: “Astrophysicists now tell us that more than 80 percent of the matter in the universe, so-called *dark matter*, cannot be observed. The unconscious is the dark matter of psychology. Its processes are responsible for all creative activity and most recollection” (Staddon 2014a, 9). The autonomy of the unconscious is not even a very new idea. Well before Sigmund Freud, the eccentric genius Samuel Butler (1835–1902) referred frequently to the unconscious in his posthumously published novel *The Way of All Flesh*, which is in effect an autobiographical study of his own psychological development.

Cognitive psychologists are admittedly more interested than behaviorists in consciousness. But the contemporary view, like Butler’s, is that consciousness is not an active agent but something like a workspace, which “allows the novel combination of material” (Baddeley 2007). Let us agree, therefore, that cognitivists and behaviorists no longer differ greatly on the role of the unconscious.

Framing is the term Kahneman and Tversky give to the effect of context and the way a problem is presented on the response that is made. The term does not occur in the 1979 paper but, with a number of other labels such as nonlinear preference and source dependence, was made necessary by new data that did not fit the original formulation. An example of framing is “The statement that ‘the odds of survival one month after surgery are 90%’ is more reassuring than the equivalent statement that ‘mortality within one month of surgery is 10%.’ Similarly, cold cuts described as ‘90% fat-free’ are more attractive than when they are described as ‘10% fat.’ The equivalence of the alternative formulations is transparent, but an individual normally sees only one formulation, and what she sees is all there is” (Kahneman 2011, 88). The way in which a question is asked (this is also sometimes termed *choice architecture*) can have a huge effect on the subject’s response.

There is a counterpart to framing in animal choice. It grows out of the consensus that learning in animals is best conceived as a process

1 of variation and selection, that is, selection by consequences, and varia-
2 tion constrained by the situation:

3
4 For example, Pavlovian conditioning, which allows a neutral stimu-
5 lus to acquire signal properties, will itself give rise to a repertoire of
6 reinforcer-related activities from which operant reinforcement can then
7 select. A stimulus associated with food, or food by itself, will induce a
8 wide range of food-related activities in a hungry animal—activities
9 from which operant contingencies can select. Pigeons peck, chickens
10 peck and scratch, raccoons manipulate. Pavlovian conditioning, with
11 (say) a food US [unconditioned stimulus], in effect frames or *labels* the
12 context as food-related. The label then limits the emitted behavior to a
13 food-related repertoire, which is defined partly by past history but also
14 by the organism's evolutionary history. (Staddon 2014a, 92)

15 The situation-induced behavioral repertoire of animals is constrained—
16 framed—in much the same way as human choice behavior. Sometimes
17 “Pavlovian framing” will facilitate learning—if the desired response is
18 within the induced repertoire; but sometimes it will not—as when the
19 induced behavior interferes with the trainer's target behavior (so-called
20 instinctive drift).

21 Note that framing in this sense means that all rewards are not equivalent—
22 as most economists seem to assume. The repertoire induced by money
23 will be different from the repertoire induced by love of ideas or a wish to
24 cure patients. Consequently, paying teachers or doctors more will not nec-
25 essarily produce better teaching or medical care.

26 Finally, let us look at Kahneman's fast-slow distinction. He contrasts
27 the quick answers he and Tversky got to their choice questions—answers
28 that were often “irrational” in the sense that they did not maximize gain—
29 with the slower and more “correct” answer that most people arrive at after
30 deliberation. The quick system responds with answers that are more
31 “available” or “accessible” than other responses that may in fact be better.
32 Kahneman (2011, 415) also tells his readers to “remember that the two
33 systems do not really exist in the brain or anywhere else.” They are ways
34 to talk about the fact that people may respond one way at first and another
35 way after given some time for reflection.

36 But there is no difference between Kahneman's System 1 and System 2
37 and what I earlier called “active” and silent” responses. The active
38 response is the first thing to occur in a given situation. But if the conse-
39

quences are unsatisfactory, the active response is eventually supplanted by another response from the “silent” repertoire—Kahneman’s “slow” system. Individual differences reflect available response repertoires of different individuals—differences that reflect different histories and propensities. Human responses are more complex than key pecks, of course. They are heuristics, rules of thumb and analytic strategies, the “adaptive toolbox.” But there is no reason to doubt that they are emitted and selected by consequences, just like the simpler response of pigeons.

The economic approach has been looking for utility functions and decision weights that best fit a set of quite variable choice data. Since these data usually depend on historical factors that are not part of the analysis, this is likely to be an endless quest. A symptom of the difficulties this causes is that many very clever people have puzzled over the fact that human behavior often violates logical axioms such as transitivity and independence.

Transitivity is simple: if A is preferred to B and B to C, than logic says that A must be preferred to C—but often people disagree.

Independence is a bit more complicated. Look at table 1, which shows two pairs of gambles, A versus B and C versus D (Kahneman and Tversky 1979, Problem 1). Boldface shows which one of each pair is generally preferred (again, there are always individual differences): B over A, but C over D. There are two things to notice about this pattern: first, people pick the (slightly) lower expected value in the first pair but the (slightly) higher EV in the second. Second, the only difference between these two pairs of gambles is that the payoff *.66*2400* (italics) has been added to both choices in A and B. Otherwise, the choice between A and B is the same as between C and D. Thus, most people’s choices violate the independence assumption. The prospect theory explanation is the primacy of the certain outcome (Gamble B), which describes the result but does not explain it.

But why on earth should violations of logical axioms like this be worrisome and consume so much mental energy? Behavior is not physics or predicate calculus. Even human beings rarely maximize in an explicit way, following all the rules of optimality theory—especially when they must decide quickly. They do not consider all the options in an unbiased, neutral, and history-independent way, and then compute the costs and benefits and choose accordingly. There is therefore *no reason whatever* that human (and animal) choice should fit any set of simple axioms.

1 **Table 1** Violation of the Independence Assumption Preferences
 2 Change When a Constant Is Added to Each Choice

3 table text to come
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16 **Conclusion**

17
 18 The problem these examples illustrate goes beyond prospect theory. It is a
 19 fundamental problem for any outcome-based theory like expected utility.
 20 EUT is a functional/optimality theory and not a mechanism. It says that
 21 behavior will adjust so that marginal utilities are matched (or whatever),
 22 but provides no causal account for how this is accomplished. But there
 23 must be a causal account, a mechanism, and that mechanism will fail to
 24 optimize—to “act rationally”—under some conditions. Hence EUT will
 25 also fail sometimes—as Kahneman and Tversky eventually recognized.
 26 They did not, I think, understand the causal-functional distinction. They
 27 thought prospect theory was what I call a real (i.e., causal) theory and so
 28 were surprised when they had to keep adding kludges to make it work
 29 with a wider range of data.

30 Functional—mechanism-free—theories are not without value, but they
 31 will always run up against limits. Theoretical behaviorism, based on the
 32 simpler problems posed by learning in animals, suggests that it may be more
 33 profitable to look at the historical factors that determine people’s response
 34 repertoire. Rather than rely on some form of utility theory as the ultimate
 35 explanation for economic behavior, future research might better examine
 36 the historical and cultural—*causal*—factors that explain why a particular
 37 question format drives people to frame a problem in a certain way, a way
 38 that allows them to pick “best in repertoire” even if it is not optimal.

39 Exactly what are the “editing” processes that cause people to perceive
 logically identical problems quite differently? What kind of training

affects how decision makers perceive different kinds of problems? The optimality approach—marginal utility theory—can help us understand a particular choice problem. It will never tell us how people actually choose.

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