for equal unhappiness with the decisions emerging from a complex of representative institutions. In any case, omitting to present the easy cases in the forms that make them easy, omitting to make them salient, and omitting to keep them salient until they have been resolved is not an argument against the capacities of voters or the use of polyarchy as a system of decision-making.

See also: Bounded and Costly Rationality; Bounded Rationality; Decision and Choice: Economic Psychology; Hierarchies and Markets; Market and Non-market Allocation; Markets and the Law; Rational Choice and Organization Theory; Rational Choice in Politics

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D. Braybrooke

Decision Research: Behavioral

Rational choice theory has been, and continues to be, the dominant theoretical framework in the social sciences. The theory is enormously influential. Yet despite its popularity, the theory is based on untenable assumptions about human nature. Decision makers, or omniscient agents with stable and well-defined tastes, satisfy internal consistency and coherence by making choices that maximize their expected utilities.

Behavioral decision researchers have taken a descriptive approach to human decision making by exploring the actual judgments and decisions that people make as individuals, groups, and organizations. Researchers have identified numerous ways in which people violate the assumptions of rationality. The field has provided psychological insights about utilities and beliefs and has offered descriptive accounts of judgment and choice. This article discusses some of the empirical violations of rational choice theory, as well as alternative descriptive accounts of actual choices. Finally, it concludes with some comments about future directions.

1. Utility-Based Violations of Rational Choice

Behavioral decision researchers have identified a number of factors that influence utilities, but are either not addressed in rational choice theory or are inconsistent with it. A few of these factors are presented below.

1.1 Loss Aversion

In rational choice theory, decision makers are assumed to consider the utility of monetary outcomes as final states. They are sensitive to total wealth, not changes in wealth. In descriptive theories such as prospect theory (Kahneman and Tversky 1979), utilities (referred to as values) apply to gains and losses relative to the status quo. Furthermore, losses have greater impact than gains of equivalent magnitude. This assumption is known as loss aversion.

Loss aversion has been offered as an explanation for a well-known finding called the endowment effect, a result that cannot be predicted by rational choice theory. In a typical experiment on endowment effects, half of the participants are randomly assigned a gift, such as a university coffee mug. These participants are sellers, and the others are buyers. Sellers state their minimum selling prices for the mugs, and buyers give their maximum buying prices. Then an experimental market is conducted. Since buyers and sellers are determined randomly, rational choice theory predicts that approximately half of the mugs should be bought and sold. However, very few mugs are ever exchanged. Furthermore, selling prices are typically larger than buying prices by a factor of two or more. The psychological explanation for this effect is loss aversion; the pain of losing the object is greater in magnitude than the pleasure of gaining that object.

The way in which an object is endowed can also influence the value that people attach to it. People who

are rewarded with an object due to exemplary performance tend to value the object more highly than people who obtain the same object based on either chance or poor performance. These results tie in nicely with other findings that show that windfall gains, such as unexpected tax rebates, lottery winnings, or inheritances, are spent more readily than other assets, presumably because they are valued less.

1.2 Framing Effects

Endowment effects demonstrate how shifts in the status quo can influence the value attached to an object. Framing effects demonstrate how shifts in the *perception* of the status quo can influence choices between otherwise identical options. Framing effects were initially demonstrated by Tversky and Kahneman (1981). A now classic example of framing effects is the 'Asian disease' problem. Participants are told, 'Imagine that the US is preparing for the outbreak of an unusual Asian disease which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows: With Program A, 200 people will be saved. With Program B, there is a 1/3 chance that 600 people will be saved, otherwise no one will be saved.' Participants are asked to select a program, and the majority pick Program A.

Another group of participants is told the same story, except the descriptions of the programs are changed from lives saved to lives lost. They read, 'With Program A, 400 people will die. With Program B, there is a 1/3 chance that no one will die, otherwise 600 people will die.' The majority select program B. Although Program A and B are identical in the two problems, preferences between programs reverse depending on the framing of options. Preferences are risk averse in the gain domain and risk seeking in the loss domain.

Framing effects go far beyond laboratory demonstrations. Johnson et al. (1993) found that preferences for automobile insurance in New Jersey and Pennsylvania varied greatly with shifts in the status quo. Both states offered coverage at similar costs, and both states offered reductions in cost if drivers would give up the right to sue other drivers if they were involved in a collision. In New Jersey, the default coverage had no right to sue, although a driver could purchase that right at additional cost. In Pennsylvania, the default coverage included this right, although drivers could decline it to reduce costs. Different 'status quos' led to large differences in choice; only 20 percent of New Jersey drivers, but as many as 75 percent of Pennsylvania drivers, purchased the right to sue. Johnson et al. estimated that if limited tort had been the status quo in Pennsylvania, drivers would have saved approximately $200 million in annual insurance costs.

1.3 Contextual Effects

Another psychological variable that influences choices but is not addressed in rational choice theory is the surrounding context or the set of options under consideration. Effects of the surrounding options can be distinguished in terms of the local context and the global context. The local context refers to one particular choice set, and the global context refers to the context that is built up after evaluating multiple choice sets. The power of both contexts to influence choice is remarkable.

The most well-known local contextual effect was demonstrated by Huber et al. (1982). They asked decision makers to choose between options A and B, each described by two attributes. Then they calculated the preference for B relative to A. At a later point, decision makers were offered a choice among options A, B, and C, where C was selected to be worse than B on both attributes, and worse than A on only one attribute. B looked better in the presence of C, and preferences for B relative to A increased with C in the choice set. This result was a violation of a normative principle known as regularity. The preference for an option should never increase with the addition of other options to the choice set. This effect is robust across choice options, order of choices, and types of experimental designs (i.e., within-subject designs, where the same subject makes both choices, and between-subject designs, where different subjects make each choice).

Global contextual effects refer to the implicit comparisons that participants make across choice sets. One example is the overall range of attribute levels. Several researchers have found that a fixed change in an attribute has greater impact when it appears in a narrow attribute range than in a wide attribute range. For example, suppose students judge the attractiveness of a set of apartments based on information about monthly rent and distance to campus. A $50 change in rent has greater impact on attractiveness ratings when the overall range of rents is narrow (e.g., $200 to $400) than when the overall range of rents is wide (e.g., $100 to $1,000). Some researchers have argued that range effects influence the relative importance of an attribute, whereas others claim that range effects stretch or shrink the utilities of the attribute levels. Evidence favors the utility interpretation.

1.4 Uneven Effects of Time on Utilities

Behavioral decision researchers are also interested in the psychological effects of time. In the normative framework, delayed outcomes are assumed to be discounted at a constant rate over time. However, numerous studies suggest that discounting varies with the decision domain, the reference point, the riskiness of the outcomes, and the sequence of outcomes. When investigating the effects of outcome sequences,

Loewenstein and Prelec showed that, when people are offered choices between sequences of dinners at restaurants, they prefer to save the nicer and more expensive dinner until last. Presumably they derive pleasure from anticipating the nicer dinner, as well as the experience of that dinner. Despite this seemingly reasonable desire, the preference pattern is inconsistent with rational choice theory. Rational choice implies that, when all else is held constant, better outcomes should be preferred sooner rather than later.

1.5 Inaccurate Forecasts of Future Preferences

Kahneman (1994) has recently pointed out yet another problem with rational choice theory. He claims that people are not always able to accurately forecast their own future preferences. To make his argument, Kahneman distinguishes among different types of utilities that he refers to as decision utilities, predicted utilities, experienced utilities, and retrospective utilities. Decision utilities reflect the satisfaction gained from outcomes in a choice context. Predicted utilities are the anticipated hedonic experiences of the outcomes, and experienced utilities are the actual hedonic experiences. Finally, retrospective utilities are the remembered experiences.

Kahneman claims that remembered utilities can systematically differ from experienced utilities because retrospective utilities are surprisingly insensitive to the duration of an experience. For example, Redelmeier and Kahneman examined moment-to-moment and retrospective evaluations of the pain experienced by patients undergoing diagnostic colonoscopy. Patients rated their discomfort every 60 seconds and then made an overall evaluation of the painfulness of the entire experience. The duration of the procedure, which ranged from four minutes to 69 minutes, did not predict retrospective evaluations. Instead, a peak-end rule, representing the average of the worst moments and the final moments of the experience, gave a reasonable description of evaluations.

If people base their choices on predicted utilities, and predicted utilities are guided by inaccurate retrospective utilities, forecasts of preferences will surely be inaccurate and choices could be suboptimal. To illustrate, Kahneman and his colleagues exposed participants to two painful experiences that involved immersing their hand in cold water. In the short experience, people immersed their hand in water that was 14 degrees Celsius for 1 minute. In the long experience, they put their hand in the same 14 degree water for 1 minute and kept it immersed for an additional minute as the temperature gradually rose to 15 degrees. People evaluated the longer experience as less painful, consistent with a peak-end rule, despite the fact that the duration of pain was longer. When later faced with a choice between the same two experiences, people preferred the longer experience over the shorter one. Results of these studies, though quite controversial, suggest enormous possibilities for decision engineering.

2. Belief-based Violations of Rational Choice

In rational choice theory, agents are assumed to weight the utilities of the outcomes by their beliefs in different states of the world. Subjective probabilities or beliefs should obey the rules of probability. Numerous studies suggest otherwise.

2.1 Posterior Probabilities

Edwards was one of the first to investigate whether people updated their beliefs according to Bayes Theorem. (See also *Bayesian Theory: History of Applications*.) He found that participants shifted their judged probabilities in the appropriate direction, but not to the right extent, a result that he called conservatism. Tversky and Kahneman (1982) later challenged his claim on the basis of the results of studies that used stories such as the 'cab problem.' Participants are told the following story.

> A cab was involved in a hit-and-run accident at night. Two cab companies, the green and the blue, operate in the city. Eighty-five percent of the cabs in the city are green and 15 percent are blue. A witness identified the cab as blue. The court tested the reliability of the witness under the same circumstances that existed on the night of the accident and concluded that the witness correctly identified each one of the two colors 80 percent of the time and failed 20 percent of the time. What is the probability that the cab involved in the accident was blue rather than green?

Although some have argued that the cab problem is not adequately specified to determine a normative solution (Birnbaum 1983), many say the Bayesian solution to it is 41 percent. The majority of participants report that there is an 80 percent chance of the cab being blue. This value is sensitive to the 80 percent accuracy of the witness, but not the 15 percent base rate for blue cabs. This result and others like it led Tversky and Kahneman to argue that people often neglect base rate information and are not Bayesians at all. Hundreds of base-rate studies followed, and these studies have identified numerous boundary conditions on base rate neglect.

In a recent review, Koehler (1996) points out that, in fact, people frequently use base rates, depending on task structure and task representation. Within-subject designs, direct experience, frequency representations, unambiguous sample spaces, and random sampling are all factors that increase the degree to which people are sensitive to base rates when judging posterior

probabilities. People are not necessarily Bayesians, but there are many situations in which they are sensitive to base rate information.

2.2 Conjunctive Probabilities

Systematic errors in subjective probabilities of conjunctive events have also been identified by behavioral decision researchers (Tversky and Kahneman 1983). In another story, Tversky and Kahneman told participants about a woman named Linda who was described as 31 years old, single, outspoken, and very bright. She majored in philosophy and cared deeply about issues of discrimination and social justice. She also participated in anti-nuclear demonstrations. Then participants were asked to rank the likelihood of various statements, including 'Linda is a bank teller' and 'Linda is a bank teller and a feminist.' Participants report that the statement, 'Linda is a bank teller and a feminist' is more probable than 'Linda is a bank teller.' Tversky and Kahneman argued that these responses were violations of the conjunction rule, according to which the judged probability of the intersection of two events cannot exceed the judged probability of either single event. They claimed that people base their beliefs on the similarity of the target description to the category prototype, a strategy known as representativeness.

Gigerenzer and his collaborators have challenged this claim and have further explored the use of frequency representations to reduce, and even eliminate, conjunction effects. (Gigerenzer and Hoffrage 1995). They have had remarkable success at reducing base rate neglect and conjunction errors with frequency formats. This topic is yet another area of considerable controversy within the field.

2.3 Disjunctive Probabilities

Behavioral decision researchers have argued that judged probabilities are often inconsistent with the disjunctive rule, according to which the judged probability of the union of two events cannot be less than the judged probability of either single event. Tversky and Koehler (1994) recently showed that people systematically estimate disjunctive probabilities as less than the component event probabilities. For example, when one group of participants estimates the number of seven-letter words that end with 'n,' and another group estimates the number of seven-letter words ending in 'ing,' the latter group generates more examples than the former group, even though the latter group's task was a subset of the former group's task. Why? It is easier to think of seven-letter words ending in 'ing' than seven-letter words ending in 'n.'

Tversky and Koehler offered a theoretical account of these effects called support theory. People assign subjective probabilities to hypotheses about the world. These probabilities can psychologically stretch or increase as the hypotheses are 'unpacked' into more explicit disjunctions. The theory explains conjunction fallacies, hypothesis generation, decisions under uncertainty, fault-tree errors, as well as choice under uncertainty, by appealing to perceptual changes in likelihood with elaboration of plausible details.

Tetlock and Belkin (1996) have examined the effects of 'unpacking' past events, as well as future events. By imagining the likelihood of retrospective events that become increasing specific and detailed, people often judge the probabilities of those events as smaller. Tetlock and Belkin suggest the 'unpacking' of past events as a remedy for the hindsight bias, or the tendency to shift one's beliefs in the direction of an outcome once it is known.

3. Psychological Frameworks

Actual decisions depend on the individual, the context, and the environment. The combined effects of these factors are often described in terms of metaphors. Early metaphors focused on the ability of decision makers to cope with uncertainty, draw inferences, and test hypotheses about the world. Decision makers were treated as intuitive scientists, statisticians, and economists. Their judgments and choices were compared to optimal methods, and deviations were studied carefully. More recently, Tetlock (1992) has suggested some alternative metaphors. People also act as intuitive politicians balancing social pressures from competing sources, intuitive prosecutors who want accountability, retribution, and justice, and even intuitive theologians who protect sacred values from contamination. 'Mistakes' and 'errors' from one perspective may be perfectly reasonable from another.

3.1 Following Social and Cultural Rules

March (1994) offered a social and cultural metaphor for decision making called rule following. Rule following may have been based on tradeoffs initially, but eventually, these decisions become 'generic' applications of norms or conventions. Rule following conveys personal information about who we are, what we eat, and when we wake up in the morning. This strategy for decision making might also reflect a desire for self-control. Rule following is especially useful for controlling one's behavior when the impact of the act requires repetition (e.g., smoking a cigarette), has prolonged delays between costs and benefits (e.g., dieting), or has long-term benefits that are harder to imagine than short-term benefits (e.g., spending versus saving). This decision strategy can often minimize effort and permit the decision maker to avoid difficult or painful tradeoffs.

Fiske (1992) maintains that all social decisions boil down to four basic rules—communal sharing, authority ranking, equality matching, and market pricing. Communal sharing stresses common bonds

among group members, as found with families, lovers, and nations. Authority ranking focuses on inherent asymmetries in relationships; some people have higher rank, privilege, or prestige than others. Equality matching stresses reciprocity. Examples include baby-sitting cooperatives or car pooling, where one ought to give back whatever one takes. In market pricing, decisions are governed by supply and demand, expected utilities, or tradeoffs between costs and benefits.

What happens when a 'rule-following' decision maker applies the wrong rule to a social situation? Tetlock and his colleagues call these cases 'taboo tradeoffs.' Proposals to place monetary values on things usually thought of as priceless, such as children, body organs, or votes, do not just trigger cognitive confusion—they activate moral outrage, contempt, and a desire for retribution. The strength of people's reactions underscores the fact that taboo tradeoffs can threaten personal identities, community ties, and even social orders.

3.2 Reason-based Decisions

When rules conflict, people look for reasons to make choices (Shafir et al. 1993). Reasons may be lists of pros and cons, or they may take the form of stories. Pennington and Hastie (1993) argue that jurors construct stories to explain the facts. They present evidence to subjects either as stories or issues and find that story organizations result in stronger and more confident jury decisions than issue organizations. Reasons allow us to justify decisions to ourselves. Shafir et al. (1993) noted some interesting decision problems that arise when people have reasons to choose an act X if an event A occurs and different reasons to choose X if A does *not* occur. But if the outcome of event A is unknown, there are no reasons *of either type* to choose X, so X is rejected.

3.3 Emotion-based Decisions

How do emotions influence choices? Is the pleasure associated with an outcome well described by the utility of that outcome? Affective evaluations of outcomes are always relative, and different emotional experiences have been described in terms of different counterfactual comparisons. Some researchers have focused on the consequences of anticipated regret. Regret occurs when the obtained outcome is worse than it would have been under another choice. Other studies have focused on anticipated disappointment. Disappointment occurs when the obtained outcome is worse than an outcome under another state of the world. Both counterfactual comparisons have important influences on hedonic experiences.

There are interesting similarities between counterfactual reference points and the status quo, a critical reference point in the assessment of value. Like value shifts around the status quo, hedonic shifts around counterfactual reference points have asymmetric effects. Imagined losses have greater emotional intensity than imagined gains. Imagined losses can be quite general. Even gains can be imagined losses if one was expecting an even larger gain. The hedonic effects of these counterfactual anchors and others may be even more ubiquitous than the powerful effects of the status quo.

Mellers et al. (1999) proposed a theory of anticipated pleasure called decision affect theory. In decision affect theory, anticipated pleasure depends on obtained outcomes, counterfactual outcomes, and expectations. The theory implies that the anticipated pleasure associated with an outcome can differ from the utility of that outcome. For example, the utility of a larger win is always greater than that of a smaller win. But a smaller win can produce greater pleasure if it was completely unexpected or if a large loss was avoided in the process.

Mellers et al. also offered a link between anticipated pleasure and choice. They proposed that, when making choices, people anticipate the pleasure they might experience with all possible outcomes as described by decision affect theory, weigh those feelings by their subjective probabilities, and select the option with greater subjective expected pleasure. This theory differs from subjective expected utility theory because anticipated pleasure can differ from utility. Maximizing anticipated pleasure does not necessarily imply an egoistic variant of hedonism. It can arise from the senses, from acts of virtue, and from the relief of pain. Likewise, pain can arise from the cessation of pleasure, injustice, or the frustration from not achieving a goal.

4. Future Directions

Behavioral decision researchers have demonstrated important limitations on judgment and choice and have conveyed the message that people violate rationality. Furthermore, they have become much more circumspect about labeling behavior as 'irrational.' Although behavioral decision researchers disagree sharply among themselves about the extent and the implications of the violations, the general message that people systematically violate the assumptions of rational choice theory has had widespread effects in the social sciences. Behavioral assumptions are now being recognized in game theory, finance and legal decision making.

Demonstrations of human errors and foibles have also raised the level of debate about what constitutes rational behavior. If people repeatedly violate normative principles, at what point should the normative principles lose their elevated status? Irrational decisions can only occur when correct decisions are clearly defined. In the real world, this condition is often violated. More than one normative solution may apply. Problems may lack sufficient detail. Further-

more, decision makers may have other things in mind, especially when tasks have flat maxima or accuracy is more important than internal consistency. People may also want to avoid regret or conform to social and institutional norms. The integration of these goals with theories of behavioral decision making will provide fertile ground for future research.

For additional reading, see Kahneman and Tversky (2000) for theory and applications of behavioral decision theory, Kagel and Roth (1995) for experimental economics, Dawes (1998) for coverage of errors and biases, and Wright and Ayton (1994) for recent research on beliefs and subjective probabilities. For reading about decision technology, see Shafer (1997) for introductory material and Pearl (1988) for more advanced material.

See also: Bayesian Theory: History of Applications; Bounded and Costly Rationality; Decision and Choice: Economic Psychology; Decision and Choice: Paradoxes of Choice; Decision and Choice: Random Utility Models of Choice and Response Time; Decision Theory: Bayesian; Decision Theory: Classical; Heuristics for Decision and Choice; Risk: Empirical Studies on Decision and Choice; Risk: Theories of Decision and Choice; Utility and Subjective Probability: Contemporary Theories; Utility and Subjective Probability: Empirical Studies

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Decision Support Systems

1. Introduction

A decision is a choice made by some agent between competing beliefs about the world or between alternative courses of action to achieve the agent's goals. The ability to reason flexibly about problems and make good choices are fundamental to any kind of intelligence and the need to do them well is highly valued in society. Consequently, there is a growing demand for *decision support systems* which can assist human decision makers make important choices more effectively. This demand has stimulated research in many

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