

RATIONALITY

Eldar Shafir and Robyn A. LeBoeuf

Department of Psychology, Princeton University, Princeton, New Jersey 08544;
e-mail: Shafir@princeton.edu, RLeBoeuf@princeton.edu

Key Words judgment, choice, decision making, normative theories, cognition

■ **Abstract** This chapter reviews selected findings in research on reasoning, judgment, and choice and considers the systematic ways in which people violate basic requirements of the corresponding normative analyses. Recent objections to the empirical findings are then considered; these objections question the findings' relevance to assumptions about rationality. These objections address the adequacy of the tasks used in the aforementioned research and the appropriateness of the critical interpretation of participants' responses, as well as the justifiability of some of the theoretical assumptions made by experimenters. The objections are each found not to seriously impinge on the general conclusion that people often violate tenets of rationality in inadvisable ways. In the process, relevant psychological constructs, ranging from cognitive ability and need for cognition, to dual process theories and the role of incentives, are discussed. It is proposed that the rationality critique is compelling and rightfully gaining influence in the social sciences in general.

CONTENTS

INTRODUCTION	492
VIOLATIONS OF NORMATIVE PRINCIPLES	493
Reasoning	493
Judgment	494
Choice	495
Variants of Utility	498
Emotion	498
Dual Process Models	499
THE OBJECTIONS	500
Trivializations of the Findings	501
Misinterpretations	503
Inappropriate Tests of Rationality	507
SUMMARY AND CONCLUSION	509

INTRODUCTION

Assumptions about rationality occupy a central role in practically all fields of inquiry in which human behavior matters. Human rationality has been celebrated as one of the species' greatest achievements and is often considered a trait that distinguishes humans from other animals. Indeed, the rationality assumption has come to constitute perhaps the most common and pivotal assumption underlying theoretical accounts of human behavior in various disciplines. In light of the rationality assumption's dominant role and its comforting view of human competence, it is not surprising that modern critiques of the rationality assumption have met with heated resistance.

The status of the rationality assumption is ultimately an empirical question (but see Cohen 1981, Dennett 1987). Consequently, the field of experimental psychology has been at the forefront of the modern rationality debate. Subtle distinctions of meaning remain outside the purview of this chapter, yet it is worth mentioning that the philosophical literature distinguishes between various senses of rationality (Harman 1995). In this chapter we review recent experimental and conceptual work that critiques the rationality assumption. We then consider recent work that has questioned the relevance or appropriateness of such critiques and conclude that the rationality assumption continues to appear misguided. We propose that its continued replacement with a behaviorally more sophisticated view promises to contribute significantly to the success of social science theories.

It is notable that the predominant theories of rationality are predicated on notions of consistency, not of substance. A person is entitled to a wide range of opinions, beliefs, and preferences; what is important is for these to cohere in a normatively defensible fashion. Thus, the term "rational" conveys a more technical meaning than its general dictionary significance of "agreeable to reason; of sound mind; sane." These latter terms may be applicable to people whose behavior is not well captured by normative accounts of rationality (cf. Simon 1978, Stein 1996). Conversely, one can imagine a person (say, a member of some bizarre cult) who satisfies all the requirements of consistency yet holds beliefs that in common parlance would be considered highly irrational.

Despite its focus on consistency, the rationality assumption remains, at least to some degree, intuitive rather than purely technical in nature. After all, computational (as well as time, attention, memory, and similar) limitations necessitate some failures of ideal rationality. Apart from those theories that are explicitly about idealized rationality rather than about possible human achievement (see, e.g., Stalnaker 1984, Gardenfors 1988), the requirements of rationality typically imposed are those that we expect people, at least to a first approximation, to be able to fulfill. It turns out that a variety of observed failures are not attributable to computational overload but, rather, to the specific ways in which people process information and make decisions. In those instances, whether people are considered to have violated rationality seems largely to depend on whether we had expected them to be able to perform the task in conformity with normative criteria (Bell et al. 1988, Shafir 1993).

For many years the predominant view in the social sciences had been that the rationality assumption is an adequate approximation for modeling and predicting human behavior. Normative theories pertinent to distinct tasks such as logical reasoning (Glymour 1992), probabilistic thinking (Ross 1997), and decision making (Edwards 1961, Luce & Raiffa 1957), served as candidate paradigms of human rationality. But then, motivated by Simon's (1955) notions of bounded rationality and later by Kahneman and Tversky's heuristics and biases program (Kahneman & Tversky 1972, 1973; Tversky & Kahneman 1973, 1974, 1983), the emphasis shifted toward documenting the persistent inadequacy of the rationality assumption. Common to most accounts of rationality is the notion that a person is largely entitled to his or her own views or preferences, but that these should cohere, should adhere to basic rules of logic and probability theory, and should not be formed or changed based on immaterial factors related to, for example, mood, context, or mode of presentation. Many studies from the past three decades, however, have documented numerous ways in which judgments and decisions do not cohere, do not follow basic principles of logic and probability, and depend systematically on just such irrelevant factors. People use intuitive strategies and simple heuristics that are reasonably effective some of the time but that also produce biases and lead to systematic error. In what follows, we briefly review some of the empirical work, mostly in the areas of judgment and choice. We then consider some recent critiques that have arisen concerning these studies' relevance and implications for the rationality assumption. Extensive reviews of the relevant findings can be found in Baron (1994), Camerer (1995), Goldstein & Hogarth (1997), Hastie (2001), Kahneman & Tversky (2000), Mellers et al. (1998), Shafir & Tversky (1995), and Yates (1990).

VIOLATIONS OF NORMATIVE PRINCIPLES

Reasoning

Some of the earliest violations of normative principles documented by experimental psychologists involved systematic deviations from simple principles of logical reasoning (e.g., Wason 1966; see Gilhooly 1988, Oakhill & Garnham 1993 for reviews). Recent contributions to this research have found certain connectives easier to reason about than others; conjunctions (e.g., "and") are easiest, followed by conditionals (e.g., "if . . . then"), exclusive disjunctions (e.g., "A or B but not both"), and finally, inclusive disjunctions (e.g., "A or B or both"), which cause participants the most difficulty (Johnson-Laird et al. 1992, 2000). Research has also been motivated by the quest to determine the mechanisms that best account for the observed reasoning competencies and difficulties. Briefly, one view is that people reason by applying abstract reasoning rules to a variety of reasoning tasks (Braine & O'Brien 1998, Rips 1994), whereas the opposing view holds that reasoning is based upon mental models that are constructed to represent the situation

at hand (Johnson-Laird 1983, Johnson-Laird & Byrne 1991). All told, research on reasoning has continued to document persistent and systematic shortcomings in reasoning abilities (see Manktelow 1999, Johnson-Laird 1999 for extensive reviews).

Judgment

Early work within the heuristics and biases paradigm concerned people's intuitive probability judgments (Kahneman et al. 1982). The general finding has been that in settings where the relevance of simple probabilistic rules is made transparent, subjects often reveal appropriate statistical intuitions (see, e.g., Tversky & Kahneman 1986). However, in slightly richer contexts, where the applicability of the normative rules is less immediately apparent, people tend to rely on intuitive heuristics that often produce nonnormative judgments.

One such heuristic is the representativeness heuristic, or the tendency to evaluate the likelihood that a target belongs to a certain class based upon the degree to which the target resembles the prototypic class member. Whereas such a strategy may often be reasonably effective, sample sizes, prior odds, and the basic axioms of probability, all of which are highly relevant to likelihood, do not impinge on how representative an observation appears and thus tend to be neglected (Kahneman & Tversky 1972, 1973; Tversky & Kahneman 1983). In a well-known example, respondents are presented with a personality description of a woman, Linda, who is highly similar to a prototypical feminist, and are asked to rate the probability that several statements about Linda are true. The majority of subjects rank the conjunct, "Linda is a bank teller" as less probable than the conjunction, "Linda is a bank teller and is active in the feminist movement" (Tversky & Kahneman 1983), thereby disregarding the fundamental conjunction rule of probability in favor of a judgment based on a highly representative, yet statistically uninformative, description. The notion that people focus on the strength of the evidence with insufficient regard for its weight explains various systematic judgmental biases, including the failure to appreciate regression phenomena and the fact that people are generally overconfident (when evidence is remarkable but reliability is low) and occasionally underconfident (when the evidence is unremarkable but highly reliable) (Griffin & Tversky 1992).

More generally, probability judgments will have gone awry when they are not "well calibrated." Consider a set of propositions, each of which a person judges to be true with a probability of 0.90. If right about 90% of these, the person is said to be well calibrated. If right about fewer or more than 90%, the person is said to be overconfident or underconfident, respectively. People typically tend to be overconfident, whether judging the likelihood that their answers to general-knowledge questions are correct (e.g., Fischhoff et al. 1977, Griffin & Buehler 1999, Lichtenstein & Fischhoff 1977; but see Dawes & Mulford 1996) or estimating the accuracy of predictions about future events or behaviors (Dunning et al. 1990, Pulford & Colman 1996, Vallone et al. 1990). In a typically regressive fashion, overconfidence is most pronounced for difficult tasks, whereas easy tasks

occasionally yield underconfidence, in what is known as the “hard-easy effect” (e.g., Lichtenstein & Fischhoff 1977).

Judgments often rely on sets of attributes—for example, a prospective applicant’s exam scores, relevant experience, and letters of recommendation—that need to be combined into a single rating, for instance, likelihood of success at the job. Because people have poor insight into how much to weight each attribute, they are typically quite poor at combining these attributes to yield a final judgment. Much research has been devoted to the shortcomings of intuitive (“clinical”) judgment, and to the greater predictive success obtained by linear models of the human judge (Dawes 1979, Dawes et al. 1989, Swets et al. 2000). In fact, it has been repeatedly shown that a linear combination of attributes, based, for example, on a judge’s past ratings, does better in predicting future (as well as previous) instances than the judge on whom these ratings are based (see, e.g., Swets et al. 2000). Essentially, this “bootstrapping” method takes advantage of the person’s insights captured across numerous ratings and improves on any single rating wherein improper weightings of attributes may intrude. Moreover, because attributes are often highly correlated and systematically misperceived, even a unit assignment of weights, not properly devised for the person, can often still outperform the human judge (Dawes 1988). Related methods have extracted from a person’s judgments a coherent core that is maximally consistent with those judgments and at the same time comes closer to the observed likelihoods than do the original (incoherent) judgments (Osherson et al. 1994, Pearl 1988).

One recent attempt to model subjective probability judgments, known as support theory (Tversky & Koehler 1994), has focused on the notion that the judged probability that some hypothesis is true will be based on the perceived strength of evidence, or support, for the hypothesis relative to the perceived support for alternate hypotheses. According to support theory, subjective probability is associated not with events but with descriptions of events. Unpacking the description of an event into disjoint components generally increases its support and, hence, its perceived likelihood. As a result, different descriptions of the same event can give rise to different judgments (Brenner & Koehler 1999, Rottenstreich & Tversky 1997, Tversky & Koehler 1994).

As already noted, people’s judgments often violate basic normative rules, yet at the same time, people can exhibit sensitivity to and appreciation for the normative principles. This coexistence of fallible intuitions with an underlying appreciation for normative judgment yields a subtle picture of probabilistic reasoning, along with interesting possibilities for a prescriptive approach. In this vein, a large literature on expert systems has attempted to provide analyses and applications (e.g., Hammond et al. 1999, von Winterfeld & Edwards 1986).

Choice

Normative analyses of choice posit consistent preferences that depend on the subjective utilities of anticipated outcomes weighted by their probabilities. To be normative, preferences must satisfy description and procedure invariance, such

that logically equivalent representations of a decision problem as well as logically equivalent methods of elicitation yield the same preferences. Recent studies of decision making have captured a number of psychological principles that characterize the decision making process and conflict with these most basic normative requirements. In general, people tend not to have clear and well-ordered preferences: Instead, preferences are actually constructed, not merely revealed, in the elicitation process, and the construction of preference is heavily influenced by the nature and context of the decision.

A number of theories have been proposed to account for the behavioral findings in choice (e.g., Bell 1982, Edwards 1962, Fellner 1965, Luce & Fishburn 1991, Mellers et al. 1997, Shafir et al. 1993a, Tversky 1972), the most influential of which has been prospect theory (Kahneman & Tversky 1979, Tversky & Kahneman 1992). Prospect theory posits that probabilities have nonlinear impacts on decisions (Gonzalez & Wu 1999, Kahneman & Tversky 1979, Prelec 2000, Tversky & Wakker 1995) and proposes an S-shaped value function with three important properties. First, the evaluation of outcomes is defined on gains and losses rather than total wealth. Second, the value function is steeper for losses than for gains: Thus, a loss of \$X is more aversive than a gain of \$X is attractive. This is commonly referred to as loss aversion (Tversky & Kahneman 1991); one consequence of loss aversion is the “endowment effect,” wherein the mere possession of a good can lead to higher valuation of it than if it were not in one’s possession (Kahneman et al. 1990). Loss aversion also creates a general reluctance to trade or depart from the status quo, because the disadvantages of departing from it loom larger than the advantages of the alternatives (Samuelson & Zeckhauser 1988). Finally, owing to diminishing sensitivity, prospect theory’s value function is concave for gains and convex for losses, yielding risk-averse attitudes in the domain of gains and risk seeking in the domain of losses (except for very low probabilities, in which case these can reverse).

The above attitudes may seem compelling and unobjectionable, yet their combination yields normatively problematic consequences. For example, because prospects can often be framed either as gains or as losses relative to some reference point, and because risk attitudes vary depending upon whether gains or losses are at stake, alternative frames may lead to discrepant preferences with respect to the same final outcome (Tversky & Kahneman 1981, 1986). In one example (Tversky & Kahneman 1986), respondents are asked to assume themselves \$300 richer and are then offered a choice between a sure gain of \$100 or an equal chance to win \$200 or nothing. Alternatively, they are asked to assume themselves \$500 richer, and offered a choice between a sure loss of \$100 and an equal chance to lose \$200 or nothing. Although the two problems are essentially identical with respect to the final outcome, most subjects who choose between gains predictably prefer the \$100 for sure, whereas most subjects who choose between losses prefer the probabilistic \$200 gamble. This is known as a “framing effect”: It occurs when alternative frames of essentially the same decision problem lead to predictably different choices. Framing effects have been replicated across a variety of domains in

dozens of studies (for reviews, see Kühberger 1998, Levin et al. 1998; RA LeBoeuf & E Shafir, in preparation).

Influential research has also focused on the relative weighting of options' different dimensions. Because people are often uncertain about the relative importance of various dimensions, the weights assigned to those dimensions are often influenced by relatively immaterial changes in the task, the description, and the nature of the options under consideration. For example, the weight given an attribute tends to be enhanced by its compatibility with a required response. Thus, a gamble's potential payoff is weighted more heavily in a pricing task (in which both the price and the payoff are expressed in the same—monetary—units) than in choice (see Shafir 1993, 1995; Slovic et al. 1990). Consistent with this is the preference reversal phenomenon (Slovic & Lichtenstein 1983, Tversky et al. 1990), wherein subjects choose a lottery offering a greater chance to win over another offering a higher payoff, but then price the latter higher than the former. Preference reversals have been replicated among professional gamblers in a Las Vegas casino (Lichtenstein & Slovic 1973) and in a context offering the equivalent of a month's salary to respondents in the Peoples' Republic of China (Kachelmeier & Shehata 1992). Preference reversals have also been documented in numerous studies involving nonmonetary options, including choice between highway safety programs, job candidates, and interventions intended to address environmental problems (Kahneman & Ritov 1994, Slovic et al. 1990, Tversky et al. 1988).

A related choice pattern, referred to as an evaluability effect, emerges when attributes are difficult to evaluate in isolation (Hsee 1996). In one example, subjects are presented with two second-hand music dictionaries, one with 20,000 entries and a damaged cover, the other with 10,000 entries and a cover that is like new. When evaluating the dictionaries separately, respondents, who have little notion of how many entries to expect, are willing to pay more for the dictionary with the new rather than the torn cover. When these dictionaries are evaluated concurrently, however, most people prefer the dictionary with more entries, despite its inferior cover (Hsee 1996, Hsee et al. 1999).

In further violation of standard value maximization, decisional conflict can lead to a greater tendency to search for alternatives when better options are available but the decision is hard than when relatively inferior options are present and the decision is easy (Tversky & Shafir 1992a). In addition to the conflict or difficulty that characterizes a decision (March 1978), choices have been shown to be influenced, often nonnormatively, by the regret anticipated in cases where another option could have been better (Bell 1982), the reasons used to justify one choice over another (Shafir et al. 1993b, Tetlock 1992), the influence exerted by costs already suffered (Arkes & Blumer 1985, Gourville & Soman 1998), and the effects of temporal ordering on future decisions (Loewenstein & Elster 1992, Loewenstein & Prelec 1993). The methodology used to document the various effects in decision making research is quite rich, including process-tracing methods, such as verbal protocols (Ericsson & Simon 1984), information-acquisition sequences (Payne et al. 1993), and eye-movement data (Russo & Doshier 1983).

Variants of Utility

Whereas discussions generally focus on the descriptive adequacy of utility maximization, recent research has explored the precise nature of utility. Kahneman (1994) questions whether people maximize the expected experienced utility of a decision, that is, the hedonic experience that the decision will bring, as opposed to merely the decision utility, that is, the utility perceived at the moment of decision.

It turns out that utility mispredictions are common. The remembered hedonic qualities of past events are subject to biased evaluations that overweigh extreme and final moments, leading to relative “duration neglect” and the occasional preference for events that are remembered more positively owing to an added diminishingly painful final episode, despite the added net amount of pain overall (Kahneman 1994, Kahneman et al. 1993). In addition to misremembering their experiences, decision makers often fail to anticipate increases in liking owing to mere exposure (Kahneman & Snell 1992), neglect the dissipation of satiation (Simonson 1990), misremember options previously encountered (Mather et al. 2000), and fail to foresee other factors, such as the effects of ownership on the valuation of objects (Van Boven et al. 2000). Finally, when predicting the impact on their lives of specific events, people tend to focus too heavily on those events, consequently overestimating the impact these events will have on their lives and their life satisfaction (Schkade & Kahneman 1998, Wilson et al. 2000). In making such forecasts, people tend to neglect the extent to which they will be able to maintain a level of satisfaction in the face of adversity (Gilbert et al. 1998, Kahneman et al. 1999). In sum, expectations of experienced utility are often inaccurate, whether they stem from biased retrospective evaluations or from misguided theories about the future. Decisions based on expectations that are systematically inaccurate are likely to result in courses of action that fail to maximize well-being, in violation of the standard tenets underlying the rationality assumption.

Emotion

Whereas emotions are typically considered outside the purview of a rational analysis, recent research has begun to explore the role of emotions in judgments and decisions. It appears that transient moods influence choice and judgment in ways that neither rationality assumptions nor intuition predict. For example, negative moods increase the perceived frequency of risks and of undesirable events (such as homicides) and decrease judged life satisfaction, while positive moods act in the opposite direction (Johnson & Tversky 1983, Schwarz & Clore 1983). Furthermore, for those in a positive mood, the pain of a loss is heightened, leading to attempts at “mood maintenance” through greater risk-aversion (Isen & Geva 1987, Isen et al. 1988). Interestingly, moods with the same valence can have differential effects on judgment; thus, anger, a negatively valenced emotion, seems to yield optimism in judgments about future risks, whereas fear, also negatively valenced, generates relative pessimism (Lerner & Keltner 2000).

Furthermore, judgments are often shaped by emotionally evaluative responses in ways not anticipated by accounts of rationality. For example, participants are willing to pay more to insure, and are more likely to seek compensation for, an item that is emotionally meaningful than for an emotionally neutral but equally valuable item (Hsee & Kunreuther 2000). Similarly, the perceived risk of things like nuclear power is related to the amount of dread that they arouse (Fischhoff et al. 1978). The evaluative reaction engendered by stimuli plays a role in the halo effect (Dion et al. 1972), and in the influence of vividness on perceived event frequency (e.g., Lichtenstein et al. 1978).

Such findings have prompted attempts at integrated views of the influences of affect on decision making. Damasio (1994) posited that good decision making requires a somatic marker, or a visceral signal that allows the decision maker to anticipate the pain and pleasure of outcomes. Similar proposals suggest that images, marked by positive and negative affective feelings, often guide decisions; because these images can be consulted more quickly and with less effort than it would take to form a judgment through normative routes, researchers have argued for the existence of an “affect heuristic” (Finucane et al. 2000, Slovic et al. 2001). Findings such as the perceived negative relationship between risk and benefit, strengthened under time pressure and purportedly mediated by affect (Finucane et al. 2000, Fischhoff et al. 1978) and the relative insensitivity to the probability of occurrence of emotionally powerful stimuli (Rottenstreich & Hsee 2001) are seen as further evidence for an affect heuristic. Loewenstein et al. (2001) suggested that anticipatory emotions not only influence cognitive appraisals of uncertain situations but compete with those appraisals in determining a response. In summary, recent decision making research has seen an increased interest in the role of affect: Transient emotions can produce behavioral responses that deviate from what is otherwise seen as the “best” plan, in ways that are not subsumed by the tenets of rationality.

Dual Process Models

People’s reasonably sophisticated normative insights, which they are able to formulate upon reflection, alongside the systematic and ubiquitous violations of normative principles in everyday decisions have led to a number of theoretical accounts that have focused on the coexistence of these two apparently discrepant impulses. These accounts have proposed dual-process theories of reasoning and judgment, suggesting that responses can reflect, at different times, the operation of one system or another (Epstein 1994, Evans & Over 1996, Osherson 1995, Sloman 1996, Stanovich 1999). For example, Epstein (1994) suggested that there is a holistic, affective, association-driven experiential system that coexists with an analytic, logical, and reason-oriented rational system. Sloman (1996) proposed an associative system that makes judgments based on similarity and regularities in the environment; this is separate from a rule-based system that operates on symbolic structures and follows explicit rules of computation. Evans & Over (1996)

distinguished habitual and tacit “type 1 rationality,” which serves to achieve everyday goals, from “type 2 rationality,” which enables people to follow explicit normative insights. In his summary of dual-process theories, Stanovich (1999) referred to “system 1” reasoning, which is automatic, largely unconscious, and undemanding of capacity, versus “system 2” reasoning, which is controlled and encompasses analytic intelligence.

Common to these theories is one process of reasoning that makes relatively automatic inferences and judgments through mainly associative means, and another process that makes relatively effortful inferences by following a set of explicitly normative rules. Only when the rule-based, analytic system is engaged, and when it cues a normative response that “overrides” the automatic, associative processing, will people successfully avoid the “irrationalities” that can be generated by the latter. For example, in the context of the Linda problem (Tversky & Kahneman 1983), the associative system might cue the response “Linda resembles a feminist bank teller;” only when the rule-based system recognizes the applicability of the conjunction rule will participants generate the normative response (cf. Epstein 1994, Sloman 1996, Stanovich 1999). It should be noted that these theories share a basic structure with other dual-process theories of information processing, such as Shiffrin & Schneider’s (1977) distinction between automatic and controlled processing and Zajonc’s (1980) distinction between immediate affective responses and more effortful cognitive responses, as well as theories of attitude change (Petty & Wegener 1999), person perception (Trope & Gaunt 1999), and stereotyping (Fiske et al. 1999; see Chaiken & Trope 1999, for further examples), all of which posit at least two basic modes of processing—one in which heuristic responses predominate and another in which more deliberate strategies take over.

Regardless of the precise account of how reasoning is performed, there seems to be compelling evidence for systematic violations of normative principles alongside the ability to appreciate their normative appeal. Rationality requires that judgments and decisions be far-sighted, contemplated in the aggregate, and made from a global perspective. Instead, research shows that they are often myopic and contemplated from a narrow and local perspective. Nonetheless, some authors have questioned the validity or importance of the empirical findings. It is to these objections that we next turn.

THE OBJECTIONS

A slew of studies and replications have solidified the status of the rationality critique over the past two decades. Perhaps not surprisingly, recent years have witnessed a resurgence in attempts to salvage the rationality assumption. One natural path has been to question the validity or relevance of the accumulated findings. This has been pursued along several lines. The first trivializes the findings by denying their import and applicability to “real” decisions. The second argues that participants are not providing wrong answers but, rather, that the researchers misinterpret the answers

as incorrect. The third line holds that researchers' expectations and demands of the participants are inappropriate, unfair, or unrealistic. These arguments and the evidence for or against them are summarized in turn (see Gilovich & Griffin 2001, Stanovich 1999 for related reviews).

Trivializations of the Findings

One way to salvage the rationality assumption is by dismissing the various findings as unsystematic, unreliable, and easily correctable once participants are sufficiently motivated. The simplest version of this argument suggests that irrationalities are nothing more than unsystematic "performance errors," merely the result of a "momentary . . . lapse in ancillary processes" (Stanovich & West 2000, p. 646; see Stein 1996, pp. 9–10). Were this the case, we should expect nothing more than error variance centered around a normative response. This version of the argument can be relatively easily dismissed. The observed deviations from rationality are clearly not random. Errors ranging from the conjunction fallacy (Tversky & Kahneman 1983), to framing effects (Tversky & Kahneman 1981), to preference reversals (Lichtenstein & Slovic 1973) all arise in specific and predictable ways. Furthermore, Stanovich & West (1998c) have found modest correlations between an individual's performance on a host of judgment and reasoning problems; such correlations would not be expected were these nothing but unsystematic errors.

A related argument, however, cannot be quite so easily dismissed. According to this argument, participants who violate basic normative principles may simply lack sufficient motivation; were they motivated, the argument goes, they would think more deeply about the task and obey the otherwise compelling normative principles. This implies that rationality violations ought mostly to emerge on trivial and inconsequential tasks. This prediction has been explored in a variety of ways.

INCENTIVES Monetary incentives have traditionally been presumed an obvious way to increase motivation. With rare exceptions, however, incentives do not decrease the incidence of nonnormative behaviors. Camerer & Hogarth (1999) reviewed 74 studies that manipulate incentives. An occasional study has been able to, for instance, improve performance on a probability matching task (Castellan 1969), or reduce the influence of an irrelevant anchor (Wright & Anderson 1989). However, most inconsistencies, such as preference reversals (Grether & Plott 1979, Lichtenstein & Slovic 1973, Kachelmeier & Shehata 1992) and framing effects (Levin et al. 1988, Tversky & Kahneman 1981) persist in the face of incentives and can even be exacerbated by them. Arkes et al. (1986) employed a prediction task in which participants had the option of using an actuarial formula; the presence of incentives led to lesser reliance on the formula and to worsened performance. Camerer & Hogarth (1999) concluded that "there is no replicated study in which a theory of rational choice was rejected at low stakes . . . and accepted at high stakes" (p. 33). Note that even when incentives are successful in raising motivation, people still need to apply the correct insights for performance to improve beyond the

mere reduction of careless error (cf. Wilson et al. 1996). Without the appropriate insight, increased motivation will lead to more enthusiastic application of an incorrect strategy and will have a small if not a deleterious effect (as in Arkes et al. 1986).

JUSTIFICATION PROVISION Another method of increasing participants' involvement has been to require them to justify their responses. However, just as incentives do not reduce the occurrence of inconsistency, neither does justification provision. To take framing effects as an example, whereas justification has at times been shown to reduce the incidence of framing effects (Sieck & Yates 1997, Takemura 1994), more often framing effects clearly persist even when justification is provided (Fagley & Miller 1987, Levin & Chapman 1990, Miller & Fagley 1991, Takemura 1993; RA LeBoeuf & E Shafir, in preparation). Again, greater involvement may increase motivation, but without the right insight at the right moment that motivation is unlikely to have a positive effect.

EXPERTISE An obvious place to look for increased involvement and sophistication is among experts, to whom the task is highly relevant and much more familiar. Numerous studies show that experts can violate the tenets of rationality in much the same fashion as lay people do. For example, Redelmeier & Shafir (1995, Redelmeier et al. 2001) found that physicians, nurses, and legislators who faced choices in their own areas of expertise were prone to violate notions of regularity (Tversky & Simonson 1993) and instrumentality (Bastardi & Shafir 1998) much as nonexperts did. Similarly, McNeil et al. (1982) found that patients, graduate students, and physicians were similarly affected by a framing manipulation of alternative therapies' mortality outcomes. Other studies similarly found expertise and experience to have little impact on the incidence of decision biases (e.g., Benartzi & Thaler 1995, Camerer et al. 1997, Neale & Northcraft 1986, Redelmeier & Tversky 1990).

In a slightly different vein, Dawes et al. (1989) concluded that actuarial decision making is often far superior to expert, or clinical, judgment. Their conclusion stems in part from studies that show that clinicians fall prey to judgmental biases, such as overconfidence (Faust et al. 1988) and the hindsight bias (Arkes et al. 1981). It appears that experts, for whom the tasks are meaningful and relevant, are as likely as nonexperts to violate simple norms of rationality. This strongly suggests that such violations cannot be attributed to lack of interest, involvement, or understanding.

NEED FOR COGNITION Despite the failure of incentives, justification, or expertise to attenuate the observed inconsistencies and biases, one more variable that has been investigated is participants' inherent need for cognition (NC) (Cacioppo & Petty 1982). NC identifies "differences among individuals in their tendency to engage in and enjoy thinking" (Cacioppo & Petty 1982, p. 116). The NC variable separates those who find fulfillment in intricate thought from those who do not seek out situations that require effortful and elaborate processing (Cacioppo &

Petty 1982). To the extent that a bias is attributable to an insufficiently serious consideration of a problem, NC might moderate the occurrence of such bias.

Smith & Levin (1996) reported a lower impact of problem frame on high-NC participants, but both Levin et al. (2001) and RA LeBoeuf & E Shafir (in preparation) found no effect of NC on framing. Stanovich & West (1999) found that those with higher NC scores were more likely, among other things, to recognize the relevance of base rates in likelihood judgments and more likely to recognize the inappropriateness of honoring sunk costs. On the other hand, they found NC scores not to be predictive of insights in hypothesis testing or Prisoner's Dilemma tasks. In fact, higher NC scores did not yield an increase in the tendency to utilize (as opposed to merely recognize the relevance of) base rates. Thus, whereas high-NC participants occasionally give more normative responses than their low-NC counterparts (especially in within-subjects contexts; see RA LeBoeuf & E Shafir, in preparation), increased thought as indexed by NC scores does not appear to rid respondents of observed inconsistencies and bias.

SUMMARY Deviations from the criteria of rational judgment and choice cannot be seen as mere "performance errors." These deviations are far too systematic, both within and across individuals, to be considered randomly distributed. The systematic biases persist in the face of a variety of attempts to increase incentives as well as other motivational factors. The biases are exhibited by experts as well as novices and cannot be dismissed as random artifacts attributable to trivial, uninteresting, or unrepresentative tasks.

Misinterpretations

Another way to salvage the rationality assumption is to suggest that researchers mistakenly attribute irrationality to what is in fact normative behavior. Such misinterpretation is said to arise owing to experimenters' and participants' purportedly different construals of the tasks (see also Gilovich & Griffin 2001, Stanovich & West 2000). According to this view, participants' responses, which are rational in light of their own construals of the task, are coded as irrational by experimenters who fail to appreciate the participants' construals (Hertwig & Gigerenzer 1999, Hilton 1995, Levinson 1995, Macdonald 1986, Schwarz 1996, Slugoski & Wilson 1998). When studies are redesigned to reduce the likelihood of alternative construals and misinterpretations, purported violations should disappear or at least be markedly reduced (Dulany & Hilton 1991, Fiedler 1988, Krosnick et al. 1990, Politzer & Noveck 1991, Schwarz et al. 1991). We explore this in the following sections.

CONVERSATIONAL IMPLICATIONS One critique starts with the premise that people must make inferences about a communicator's intent and that, in making such inferences, people typically presume that communicators are following the maxims of relevance and nonredundancy (Grice 1975). Participants in experiments,

according to this critique, do not always realize that the experimenter may flout a Gricean maxim, for example, by volunteering irrelevant information. Consequently, they make inferences about the experimenter's presumed intent and base their judgments on inferred as well as available information, whereas the experimenter expects evaluations based solely on available information (Hilton 1995, Levinson 1995, Schwarz 1996).

Prominent targets of this critique have been violations of the conjunction rule as exhibited by performance on the Linda problem described earlier (Tversky & Kahneman 1983). Researchers have investigated the inferences that people draw when presented with the conjunct ("Linda is a bank teller") juxtaposed with the conjunction ("Linda is a bank teller and is active in the feminist movement"). Respondents, it is argued, may expect a cooperative communicator not to pose a trivial question such as "Is A more or less probable than A and B?" and may thus infer that further interpretation is necessary (Politzer & Noveck 1991), leading to the reformulation of the conjunct as meaning "A and not B" (cf. Dulany & Hilton 1991, Levinson 1995).

Anticipating such critique, Tversky & Kahneman (1983) replaced the conjunct with "Linda is a bank teller whether or not she is active in the feminist movement." Whereas the incidence of the conjunction fallacy diminished, the fallacy persisted among the majority of participants. A number of researchers, however, remained unconvinced and further explored potential alternative interpretations of the items.

Dulany & Hilton (1991), for example, found that they could reduce the prevalence of the conjunction fallacy to a minority of subjects (38% or fewer) by rewording the conjunct to include some helpful logical clues. Furthermore, through interviews with participants, they ascertained that the majority who committed the conjunction fallacy did not interpret the conjunct in its extensional, or normative, form. Politzer & Noveck (1991) similarly found that explicit, as opposed to implicit, conjunctions indeed encouraged alternate interpretations of the conjunct. In a related vein, Slugoski & Wilson (1998) found that the tendency to commit the conjunction fallacy was correlated with a person's conversational skill and proposed that the fallacy is due to a process of interpretation, not necessarily an inability to reason.

Despite these observations, it appears unlikely that the conjunction fallacy can be relegated to a flouting of Gricean conventions. First, Tversky & Kahneman (1983) observed the conjunction fallacy across a wide variety of problems, including some for which implicatures are not easily invited (e.g., the "Bjorn Borg" problem). Second, Tversky & Kahneman observed the conjunction effect in a between-subjects design in which the conjunct was rated as less probable than the conjunction even though the two were seen by different participants (but see Hertwig & Gigerenzer 1999, Politzer & Noveck 1991 for questions about the relevance of between-subjects findings). Agnoli & Krantz (1989) found that instruction in set theory could diminish the incidence of the conjunction fallacy, which would not be expected if participants reinterpreted the conjunct to mean that the conjunction was not its subset. Agnoli & Krantz also noted that replacing the conjunct

with its purported reinterpretation (A and not B) increased the difference between the likelihood assigned the replacement statement and the original conjunction, a pattern that would not be expected under the spontaneous reinterpretation notion. Finally, Morier & Borgida (1984) included the conjunct, the original conjunction, as well as the purported reinterpretation among the response alternatives. This should have obviated the purported need to reinterpret, yet 77% of participants committed the conjunction fallacy on the Linda problem.

Findings of insufficient reliance on base-rate information in likelihood judgments (Kahneman & Tversky 1973) sparked similar discussions regarding possible conversational inferences (see Schwarz 1996). In a typical experiment, participants are presented with a vignette drawn randomly from some population (consisting, e.g., of 70 lawyers and 30 engineers) and asked the likelihood that the description belongs to a particular member of that population (e.g., a lawyer). Estimates are typically under-influenced by the base rate, and over-influenced by the representativeness of the description (Kahneman & Tversky 1973). It was suggested that perhaps participants are led to infer that the description is important, and that it is this inference, not a general reluctance to rely on base rates, that underlies the apparent error (Schwarz 1996, Schwarz et al. 1991).

In the original studies (Kahneman & Tversky 1973), base rates were given first and then the individuating description was added; this order of presentation, some have proposed, may have suggested that base rates were insufficient for the task. Krosnick et al. (1990) varied the order in which the information was presented and, indeed, found that reliance on base rates increased when base-rate information was presented after the description. Also, in the original studies, in which the personality description was purportedly compiled by psychologists, participants may have inferred that it was carefully constructed and perhaps valid. When the description was said to have been randomly sampled, unreliable, or informative to "statistical" experts, reliance on base rates increased significantly (Ginossar & Trope 1987, Schwarz et al. 1991). Finally, when base rates were made to vary, reliance on base rates increased (Fischhoff et al. 1979, Schwarz et al. 1991). Whereas some instances of base rate neglect may be attributable to conversational factors, as suggested above, the data continue to suggest that an under-reliance on base rates, perhaps less extreme than occasionally observed, nevertheless characterizes people's judgments (Fischhoff et al. 1979, Schwarz et al. 1991).

Conversational considerations have also been invoked with regard to framing effects. In the context of the Asian Disease problem (Tversky & Kahneman 1981), for example, researchers have suggested that the two (purportedly isomorphic) frames presented could be construed as nonisomorphic (Berkeley & Humphreys 1982, Macdonald 1986). However, Stanovich & West (1998b), using a within-subjects design, showed that most participants, especially those of higher cognitive ability, recognize the two frames as extensionally identical. Violations of normative criteria are often overdetermined; many factors can combine to produce such violations, and conversational misinterpretations may be one, but are unlikely to be

a major, contributor to the observed effects (cf. Gilovich & Griffin 2001, Schwarz 1996).

ALTERNATIVE INTERPRETATIONS OF TERMS AND TASKS Some attempts to dismiss the observed findings have focused on the possibility that respondents' interpretations of the terms or tasks are different from those assumed by the experimenters who present them. One such line of criticism hinges on the use of the term "probability." There are at least two distinct philosophical conceptions of probability (Howson & Urbach 1989, Keynes 1921, von Mises 1957). According to one, probabilities refer to the relative frequencies of objective physical events in repeated trials; according to the other, probabilities are epistemic in nature, expressing degrees of belief in specific hypotheses. Note, though, that these different conceptions of probability are arguably constrained by the same mathematical axioms. Adherence to the axioms suffices to insure that probability judgment is coherent. Nonetheless, this distinction is at the core of an ongoing debate concerning the status and interpretation of some experimental findings (see, e.g., Cosmides & Tooby 1996; Fiedler 1988; Gigerenzer 1994, 1996a; Kahneman & Tversky 1996).

For example, Gigerenzer (1994; see also Macdonald 1986) noted that the conjunction fallacy, observed when asking for the probability of single events, violates some theories of probability but does not violate the frequentist conception of probability. Furthermore, Hertwig & Gigerenzer (1999) argued that participants who commit the fallacy generally do not interpret "probability" mathematically. They showed that preceding probability judgments with typicality judgments reduces the incidence of the conjunction fallacy, suggesting that participants can interpret probability mathematically but tend not to do so spontaneously. The conjunction fallacy, however, has also been shown in frequentistic formats (Tversky & Kahneman 1983, Kahneman & Tversky 1996). Furthermore, most respondents do not subscribe to a frequentistic interpretation, because they appear to find the notion of a single event probability natural and clear (Kahneman & Tversky 1996). In fact, it appears that the standard conception of probability endorsed by experimenters is also endorsed by participants with greater cognitive ability (Stanovich & West 1998b).

A similar objection concerns the possible reinterpretation of task instructions. For example, incorrect responses on the Wason selection task (Wason 1966) are typically seen as indicative of errors in deductive reasoning. However, Oaksford & Chater (1996) suggested that participants might see their task as involving optimal data selection for inductive hypothesis testing, which would explain the supposed incorrect responses when the task has abstract or otherwise nondeontic content, as opposed to the improved performance with deontic content. By this account, variations from the modal responses should merely constitute error variance. However, Stanovich & West (1998a) found a larger-than-expected set of participants who gave either the correct or the incorrect response in both the nondeontic and deontic versions, suggesting a frequent construal of the task as one involving deductive reasoning.

A review of the findings suggests that observed violations of the requirements of rationality cannot be explained away by attributing to respondents alternative construals of problems. Of course, understanding participants' construals of situations has been very important, particularly in social psychology (Griffin & Ross 1991). Various considerations that enter into peoples' construals of decision situations have been explored, including fairness (Kahneman et al. 1986), anticipated regret (Bell 1982, Tversky 1975), wishful thinking (Quattrone & Tversky 1984), and impression management (Sen 1993), among others. However, not all construals of every problem can be considered legitimate lest the theory of rational choice be stripped of any normative impact (see Margolis 1987). In fact, some misconstruals may be at the very heart of the counter-normative behaviors they help generate. Stanovich & West (2000, Stanovich 1999) attempted to find an "expert wide reflective equilibrium" such that normative principles, philosophical considerations, intuition, and expert opinion come into balance in regards to whether alternative interpretations are seen as potentially normative; they conclude that the standard normative construals are, for the most part, appropriate.

Inappropriate Tests of Rationality

Other objections to the documented violations of rational choice and judgment focus not on the results as much as on the appropriateness of the tests used to obtain them.

COMPUTATIONAL LIMITATIONS A fundamental challenge questions whether the observed biases and errors emerge simply because the normative responses are out of reach for people. Clearly, rationality should not be defined in a manner that renders it unattainable by most people (Harman 1995, Stich 1990). If the tasks are unfairly demanding, we learn little from observing participants' inability to solve them.

For many of the findings that form the core of the rationality critique this argument simply does not apply. Simple violations of well-ordering in choice, for example, such as standard framing effects (Tversky & Kahneman 1981), the asymmetric dominance effect (Huber et al. 1982, Simonson & Tversky 1992), the effects of noninstrumental searches (Bastardi & Shafir 1998), and the variety of preference reversals discussed earlier all impose remarkably simple demands; the difficulties appear to reside not in any computational demands, but in the fact that preferences are malleable and thus prone to systematic violations of well-ordering.

Demonstrated, albeit imperfect, improvements in statistical reasoning following instruction also suggest that the difficulties are often not computational but rather conceptual in nature (see, e.g., Agnoli & Krantz 1989, Fong & Nisbett 1991, Frank et al. 1993). Furthermore, various errors and inconsistencies that are systematically exhibited when the applicability of a relevant principle goes undetected are easily avoided once it is transparent (e.g., Fiedler 1988, Tversky & Kahneman 1986, Tversky & Shafir 1992b). As before, the difficulty appears to reside not in the

required computation, but in the intuitive heuristic procedures that are used unless their possible inappropriateness is made salient.

INAPPROPRIATE PROBLEM FORMATS The nature of the particular problems used has also been questioned, particularly in light of findings suggesting that performance can be improved if the problems are altered. Researchers approaching the question of rationality from an evolutionary perspective, for example, have argued that the tasks provided are typically not the tasks that participants' cognitive mechanisms have evolved to be good at. When evolutionarily more appropriate tasks are employed, the argument holds, performance improves (Cosmides & Tooby 1996, Gigerenzer 1996b). For example, it is known that performance can be improved when problems are posed in terms of frequencies rather than likelihood judgments (Cosmides & Tooby 1996, Fiedler 1988, Gigerenzer et al. 1991, Hertwig & Gigerenzer 1999, Tversky & Kahneman 1983), although performance can also be hurt by frequency formats (see Griffin & Buehler 1999). Evolutionary psychologists have proposed that the ability to encode frequencies was useful in the Pleistocene age, and the corresponding cognitive mechanisms were thus selected for, whereas the ability to determine the likelihood of single events was not (Cosmides & Tooby 1996). Similarly, improved performance on the Wason selection task when the content requires participants to check for violations of social contracts is attributed to a "cheater-detection" module that was ostensibly selected for through evolution (Cosmides & Tooby 1992, Gigerenzer & Hug 1992).

Even if these arguments were correct, the fact remains that many problems encountered in everyday life are not presented in evolutionarily advantageous ways and may thus generate incorrect responses. In fact, the successful elicitation of improved performance with certain formats suggests that people do indeed have the required competence and that they tend to agree about the correct norms (Stanovich 1999, Stein 1996). Of course, the fact that some biases are more or less easy to avoid depending on question format is not surprising or inconsistent with nonevolutionary accounts of problem solving and judgment (Gick & Holyoak 1980, Reed 1993). For example, it has been suggested that frequency formats may make extensional considerations easier to bring to mind (Tversky & Kahneman 1983; but see Hertwig & Gigerenzer 1999).

INAPPROPRIATE NORMS Yet another argument regarding the appropriateness of studies of rationality centers on whether the appropriate normative standards are being used (cf. Gigerenzer 1996a, Gigerenzer et al. 1991, Lopes & Oden 1991, Wetherick 1971). Several economists tried to effect a compromise between normative accounts and descriptive findings by retaining some of the more normatively appealing principles, such as dominance and invariance, while relaxing others, such as independence and transitivity (see Camerer 1990, 1995; Machina 1982). In a similar fashion some researchers have attempted to address the rationality critique by changing some normative criteria so that the normative and descriptive may be more in line (Stein 1996).

Allowing departures from otherwise appealing normative criteria is problematic. For one thing, incoherent judgment entails the possible holding of contradictory beliefs and likelihood judgments that, when translated into bets that the person deems fair, create a set of bets that the person is bound to lose no matter how things turn out (Osherson 1995, Resnik 1987, Stein 1996). Not only do individuals who violate the simple laws of probability or preference leave themselves exposed to situations in which they are bound to lose, but the normative principles are, in fact, typically endorsed by those who occasionally violate them. Stanovich & West (1999) presented participants with normative as well as non-normative arguments, and found that participants who changed their responses were often more likely to do so in the normative direction (see also Tversky & Kahneman 1983). Furthermore, in many of the tasks that these investigators studied, those who respond normatively score higher on the SAT as well as other cognitive ability measures (Stanovich & West 1998a,b,c). It appears that greater awareness of the normative principles, indexed by cognitive ability, presentation formats, or through explicit explication, is often associated with greater support for their normative appeal (but see Dawes & Mulford 1996, Hoch 1987, Stanovich & West 1998c for instances in which standard normative principles might not be appropriate).

Perhaps the most extreme argument has suggested that rationality is not to be settled empirically, because evolution will have necessarily produced organisms that form true beliefs and that reason rationally (e.g., Dennett 1987, Fodor 1975; see Stanovich 1999, Stein 1996, Stich 1990 for reviews). As others have written, these arguments misconstrue the function of evolution and of natural selection (Lewontin 1990, Stein 1996). There is no basis for assuming that evolution will have produced creatures whose behavior conforms to the rational principles that they have endorsed, and there is, therefore, no reason to question the appropriateness of studies that try to gauge these principles' empirical status.

SUMMARY AND CONCLUSION

Various arguments have been made disputing the accumulation of findings that show people systematically violating fundamental normative principles of reasoning, judgment, and decision. This review suggests that the violations cannot be dismissed as either random or trivial, nor can they be attributed to experimenters' misinterpretation of answers that are actually appropriate to alternative, valid interpretations of the problems. The systematic and well-documented findings cannot be attributed to simple computational limitations, nor does it appear that inappropriate types of questions are being asked or inappropriate norms applied. The compelling nature of the rationality critique is having an ever greater impact on work in neighboring disciplines, most notably in the increasing popularity of behavioral economics (Rabin 1998, Sunstein 2000, Thaler 1992, 1993). It may eventually help alter the social sciences' view of the human agent.

Visit the Annual Reviews home page at www.AnnualReviews.org

LITERATURE CITED

- Agnoli F, Krantz DH. 1989. Suppressing natural heuristics by formal instruction: the case of the conjunction fallacy. *Cogn. Psychol.* 21:515–50
- Arkes HR, Blumer C. 1985. The psychology of sunk cost. *Org. Behav. Hum. Decis. Process.* 35:124–40
- Arkes HR, Dawes RM, Christensen C. 1986. Factors influencing the use of a decision rule in a probabilistic task. *Org. Behav. Hum. Decis. Process.* 37:93–110
- Arkes HR, Wortmann RL, Saville PD, Harkness AR. 1981. Hindsight bias among physicians weighing the likelihood of diagnoses. *J. Appl. Psychol.* 66:252–54
- Baron J. 1994. *Thinking and Deciding*. New York: Cambridge Univ. Press. 2nd ed.
- Bastardi A, Shafir E. 1998. On the pursuit and misuse of useless information. *J. Pers. Soc. Psychol.* 75:19–32
- Bell DE. 1982. Regret in decision making under uncertainty. *Oper. Res.* 30:961–81
- Bell DE, Raiffa H, Tversky A, eds. 1988. *Decision Making: Descriptive, Normative, and Prescriptive Interactions*. New York: Cambridge Univ. Press
- Benartzi S, Thaler R. 1995. Myopic loss aversion and the equity premium puzzle. *Q. J. Econ.* 110:73–92
- Berkeley D, Humphreys P. 1982. Structuring decision problems and the “bias heuristic.” *Acta Psychol. (Amst.)* 50:201–52
- Braine MDS, O’Brien DP, eds. 1998. *Mental Logic*. Mahwah, NJ: Erlbaum
- Brenner LA, Koehler DJ. 1999. Subjective probability of disjunctive hypotheses: local-weight models for decomposition of evidential support. *Cogn. Psychol.* 38:16–47
- Cacioppo JT, Petty RE. 1982. The need for cognition. *J. Pers. Soc. Psychol.* 42:116–31
- Camerer CF. 1990. Behavioral game theory. In *Insights in Decision Making: A Tribute to Hillel J. Einhorn*, ed. RM Hogarth, pp. 311–36. Chicago: Univ. Chicago Press
- Camerer CF. 1995. Individual decision making. In *Handbook of Experimental Economics*, ed. JH Kagel, A Roth, pp. 587–703. Princeton, NJ: Princeton Univ. Press
- Camerer CF, Babcock L, Loewenstein G, Thaler R. 1997. Labor supply of New York City cab drivers: one day at a time. *Q. J. Econ.* 112:407–441
- Camerer CF, Hogarth RM. 1999. The effects of financial incentives in experiments: a review and capital-labor-production framework. *J. Risk Uncertain.* 19:7–42
- Castellan NJ. 1969. Effect of change of payoff in probability learning. *J. Exp. Psychol.* 79:178–82
- Chaiken S, Trope Y. 1999. *Dual-Process Theories in Social Psychology*. New York: Guilford
- Cohen LJ. 1981. Can human irrationality be experimentally demonstrated? *Behav. Brain Sci.* 4:317–70
- Cosmides L, Tooby J. 1992. Cognitive adaptations for social exchange. In *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, ed. J Barkow, L Cosmides, J Tooby, pp. 163–228. New York: Oxford Univ. Press
- Cosmides L, Tooby J. 1996. Are humans good intuitive statisticians after all? Rethinking some conclusions from the literature on judgment under uncertainty. *Cognition* 58:1–73
- Damasio AR. 1994. *Descartes’ Error: Emotion, Reason, and the Human Brain*. New York: Avon
- Dawes RM. 1979. The robust beauty of improper linear models in decision making. *Am. Psychol.* 34:571–82
- Dawes RM. 1988. *Rational Choice in an Uncertain World*. New York: Harcourt Brace Jovanovich
- Dawes RM, Faust D, Meehl PE. 1989. Clinical versus actuarial judgment. *Science* 243:1668–74

- Dawes RM, Mulford M. 1996. The false consensus effect and overconfidence: flaws in judgment or flaws in how we study judgment? *Org. Behav. Hum. Decis. Process.* 65:201–11
- Dennett DC. 1987. *The Intentional Stance*. Cambridge, MA: MIT Press
- Dion K, Berscheid E, Walster E. 1972. What is beautiful is good. *J. Pers. Soc. Psychol.* 24:285–90
- Dulany DE, Hilton DJ. 1991. Conversational implicature, conscious representation, and the conjunction fallacy. *Soc. Cogn.* 9:85–110
- Dunning D, Griffin DW, Milojkovic JD, Ross L. 1990. The overconfidence effect in social prediction. *J. Pers. Soc. Psychol.* 58:568–81
- Edwards W. 1961. Behavioral decision theory. *Annu. Rev. Psychol.* 12:473–98
- Edwards W. 1962. Subjective probabilities inferred from decisions. *Psychol. Rev.* 69:109–35
- Epstein S. 1994. Integration of the cognitive and the psychodynamic unconscious. *Am. Psychol.* 49:709–24
- Ericsson KA, Simon HA. 1984. *Protocol Analysis: Verbal Reports as Data*. Cambridge, MA: MIT Press
- Evans JStBT, Over DE. 1996. *Rationality and Reasoning*. Hove, UK: Psychology Press
- Fagley NS, Miller PM. 1987. The effects of decision framing on choice of risky vs. certain options. *Org. Behav. Hum. Decis. Process.* 39:264–77
- Faust D, Hart KJ, Guilmette TJ. 1988. Pediatric malingering: the capacity of children to fake believable deficits on neuropsychological testing. *J. Consult. Clin. Psychol.* 56:578–82
- Fellner W. 1965. *Probability and Profit: A Study of Economic Behavior along Bayesian Lines*. Homewood, IL: Irwin
- Fiedler K. 1988. The dependence of the conjunction fallacy on subtle linguistic factors. *Psychol. Res.* 50:123–29
- Finucane ML, Alhakami A, Slovic P, Johnson SM. 2000. The affect heuristic in judgments of risks and benefits. *J. Behav. Decis. Mak.* 13:1–17
- Fischhoff B, Slovic P, Lichtenstein S. 1977. Knowing with certainty: the appropriateness of extreme confidence. *J. Exp. Psychol. Hum. Percept. Perform.* 3:552–64
- Fischhoff B, Slovic P, Lichtenstein S. 1979. Subjective sensitivity analysis. *Org. Behav. Hum. Perform.* 23:339–59
- Fischhoff B, Slovic P, Lichtenstein S, Reid S, Combs B. 1978. How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sci.* 9:127–52
- Fiske ST, Lin M, Neuberg SK. 1999. The continuum model: ten years later. See Chaiken & Trope 1999, pp. 231–54
- Fodor J. 1975. *The Language of Thought*. New York: Crowell
- Fong GT, Nisbett RE. 1991. Immediate and delayed transfer of training effects in statistical reasoning. *J. Exp. Psychol.: Gen.* 120:34–45
- Frank RH, Gilovich T, Regan DT. 1993. Does studying economics inhibit cooperation? *J. Econ. Perspect.* 7:159–71
- Gardenfors P. 1988. *Knowledge in Flux*. Cambridge, MA: MIT Press
- Gick M, Holyoak K. 1980. Analogical problem solving. *Cogn. Psychol.* 12:306–55
- Gigerenzer G. 1994. Why the distinction between single-event probabilities and frequencies is important for psychology (and vice versa). In *Subjective Probability*, ed. G Wright, P Ayton, pp. 129–61. New York: Wiley
- Gigerenzer G. 1996a. On narrow norms and vague heuristics: a reply to Kahneman and Tversky. *Psychol. Rev.* 103:592–96
- Gigerenzer G. 1996b. Rationality: why social context matters. In *Interactive Minds: Life-Span Perspectives on the Social Foundation of Cognition*, ed. PB Baltes, U Staudinger, pp. 319–46. Cambridge: Cambridge Univ. Press
- Gigerenzer G, Hoffrage U, Kleinbolting H. 1991. Probabilistic mental models: a Brunswickian theory of confidence. *Psychol. Rev.* 98:506–28
- Gigerenzer G, Hug K. 1992. Domain-specific

- reasoning: social contracts, cheating and perspective change. *Cognition* 43:127–71
- Gilbert DT, Pinel EC, Wilson TD, Blumberg SJ, Wheatley TP. 1998. Immune neglect: a source of durability bias in affective forecasting. *J. Pers. Soc. Psychol.* 75:617–38
- Gilhooly K. 1988. *Thinking: Directed, Undirected and Creative*. New York: Academic. 2nd ed.
- Gilovich TD, Griffin DW. 2001. Heuristics and biases: then and now. See Gilovich et al. 2001. In press
- Gilovich TD, Griffin DW, Kahneman D, eds. 2001. *Heuristics and Biases: The Psychology of Intuitive Judgment*. Cambridge: Cambridge Univ. Press. In press
- Ginossar Z, Trope Y. 1987. Problem solving in judgment under uncertainty. *J. Pers. Soc. Psychol.* 52:464–74
- Glymour CN. 1992. *Thinking Things Through: An Introduction to Philosophical Issues and Achievements*. Cambridge, MA: MIT Press
- Goldstein WM, Hogarth RM. 1997. *Research on Judgment and Decision Making: Currents, Connections, and Controversies*. Cambridge: Cambridge Univ. Press
- Gonzalez R, Wu G. 1999. On the shape of the probability weighting function. *Cogn. Psychol.* 38:129–66
- Gourville JT, Soman D. 1998. Payment depreciation: the behavioral effects of temporally separating payments from consumption. *J. Consum. Res.* 25:160–74
- Grether D, Plott C. 1979. Economic theory of choice and the preference reversal phenomenon. *Am. Econ. Rev.* 69:623–38
- Grice HP. 1975. Logic and conversation. In *The Logic of Grammar*, ed. D Davidson, G Harman, pp. 64–75. Encino, CA: Dickenson
- Griffin DW, Buehler R. 1999. Frequency, probability, and prediction: easy solutions to cognitive illusions? *Cogn. Psychol.* 38:48–78
- Griffin DW, Ross L. 1991. Subjective construal, social inference, and human misunderstanding. In *Advances in Experimental Social Psychology*, ed. L Berkowitz, 24:319–59. San Diego, CA: Academic
- Griffin DW, Tversky A. 1992. The weighing of evidence and the determinants of confidence. *Cogn. Psychol.* 24:411–35
- Hammond J, Keeney R, Raiffa H. 1999. *Smart Choices: A Practical Guide to Making Better Decisions*. Boston: Harvard Bus. Sch. Press
- Harman G. 1995. Rationality. See Smith & Osherson 1995, pp. 175–211
- Hastie R. 2001. Problems for judgment and decision making. *Annu. Rev. Psychol.* 52:653–83
- Hertwig R, Gigerenzer G. 1999. The “conjunction fallacy” revisited: how intelligent inferences look like reasoning errors. *J. Behav. Decis. Mak.* 12:275–305
- Hilton DJ. 1995. The social context of reasoning: conversational inference and rational judgment. *Psychol. Bull.* 118:248–71
- Hoch SJ. 1987. Perceived consensus and predictive accuracy: the pros and cons of projection. *J. Pers. Soc. Psychol.* 53:221–34
- Howson C, Urbach P. 1989. *Scientific Reasoning: The Bayesian Approach*. La Salle, IL: Open Court
- Hsee CK. 1996. The evaluability hypothesis: an explanation of preference reversals between joint and separate evaluations of alternatives. *Org. Behav. Hum. Decis. Process.* 67:247–57
- Hsee CK, Kunreuther H. 2000. The affection effect in insurance decisions. *J. Risk Uncertain.* 20:141–59
- Hsee CK, Blount S, Loewenstein G, Bazerman M. 1999. Preference reversals between joint and separate evaluations: a review and theoretical analysis. *Psychol. Bull.* 125:576–90
- Huber J, Payne JW, Puto C. 1982. Adding asymmetrically dominated alternatives: violations of regularity and the similarity hypothesis. *J. Consum. Res.* 9:90–98
- Isen AM, Geva N. 1987. The influence of positive affect on acceptable level of risk: the person with a large canoe has a large worry. *Org. Behav. Hum. Decis. Process.* 39:145–54
- Isen AM, Nygren TE, Ashby FG. 1988. Influence of positive affect on the subjective

- utility of gains and losses: It is just not worth the risk. *J. Pers. Soc. Psychol.* 55:710–17
- Johnson EJ, Tversky A. 1983. Affect, generalization, and the perception of risk. *J. Pers. Soc. Psychol.* 45:20–31
- Johnson-Laird PN. 1983. *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*. Cambridge, MA: Harvard Univ. Press
- Johnson-Laird PN. 1999. Deductive reasoning. *Annu. Rev. Psychol.* 50:109–35
- Johnson-Laird PN, Byrne RMJ. 1991. *Deduction*. Hillsdale, NJ: Erlbaum
- Johnson-Laird PN, Byrne RMJ, Schaeken WS. 1992. Propositional reasoning by model. *Psychol. Rev.* 99:418–39
- Johnson-Laird PN, Legrenzi P, Girotto V, Legrenzi MS. 2000. Illusions in reasoning about consistency. *Science* 288:531–32
- Kachelmeier SJ, Shehata M. 1992. Examining evidence from the People's Republic of China. *Am. Econ. Rev.* 82:1120–41
- Kahneman D. 1994. New challenges to the rationality assumption. *J. Inst. Theor. Econ.* 150:18–36
- Kahneman D, Diener E, Schwarz N, eds. 1999. *Well-Being: The Foundations of Hedonic Psychology*. New York: Russell Sage Found.
- Kahneman D, Fredrickson BL, Schreiber CA, Redelmeier DA. 1993. When more pain is preferred to less: adding a better end. *Psychol. Sci.* 4:401–5
- Kahneman D, Knetsch JL, Thaler RH. 1986. Fairness and the assumptions of economics. *J. Bus.* 59(Suppl.):285–300
- Kahneman D, Knetsch JL, Thaler R. 1990. Experimental tests of the endowment effect and the Coase theorem. *J. Polit. Econ.* 98:1325–48
- Kahneman D, Ritov I. 1994. Determinants of stated willingness to pay for public goods: a study in the headline method. *J. Risk Uncertain.* 9:5–38
- Kahneman D, Slovic P, Tversky A, eds. 1982. *Judgment Under Uncertainty: Heuristics and Biases*. Cambridge: Cambridge Univ. Press
- Kahneman D, Snell J. 1992. Predicting a changing taste: do people know what they will like? *J. Behav. Decis. Mak.* 5:187–200
- Kahneman D, Tversky A. 1972. Subjective probability: a judgment of representativeness. *Cogn. Psychol.* 3:430–54
- Kahneman D, Tversky A. 1973. On the psychology of prediction. *Psychol. Rev.* 80:237–51
- Kahneman D, Tversky A. 1979. Prospect theory: an analysis of decision under risk. *Econometrica* 47:263–91
- Kahneman D, Tversky A. 1996. On the reality of cognitive illusions. *Psychol. Rev.* 103:582–91
- Kahneman D, Tversky A, eds. 2000. *Choices, Values, and Frames*. New York: Cambridge Univ. Press/Russell Sage Found.
- Keynes JM. 1921. *A Treatise on Probability*. London: Macmillan
- Krosnick JA, Li F, Lehman DR. 1990. Conversational conventions, order of information acquisition, and the effect of base rates and individuating information on social judgments. *J. Pers. Soc. Psychol.* 59:1140–52
- Kühberger A. 1998. The influence of framing on risky decisions: a meta-analysis. *Org. Behav. Hum. Decis. Process.* 75:23–55
- Lerner JS, Keltner D. 2000. Beyond valence: toward a model of emotion-specific influences on judgment and choice. *Cogn. Emot.* 14:473–93
- Levin IP, Chapman DP. 1990. Risk taking, frame of reference, and characterization of victim groups in AIDS treatment decisions. *J. Exp. Soc. Psychol.* 26:421–34
- Levin IP, Chapman DP, Johnson RD. 1988. Confidence in judgments based on incomplete information: an investigation using both hypothetical and real gambles. *J. Behav. Decis. Mak.* 1:29–41
- Levin IP, Gaeth GJ, Schreiber J, Lauriola M. 2001. A new look at framing effects: distribution of effect sizes, individual differences, and independence of types of effects. *Org. Behav. Hum. Decis. Process.* In press
- Levin IP, Schneider SL, Gaeth GJ. 1998. All frames are not created equal: a typology and

- critical analysis of framing effects. *Org. Behav. Hum. Decis. Process.* 76:149–88
- Levinson SC. 1995. Interactional biases in human thinking. In *Social Intelligence and Interaction*, ed. E Goody, pp. 221–60. Cambridge: Cambridge Univ. Press
- Lewontin R. 1990. The evolution of cognition. In *An Invitation to Cognitive Science*, ed. EE Smith, DN Osherson, 3:229–46. Cambridge, MA: MIT Press. 1st ed.
- Lichtenstein S, Fischhoff B. 1977. Do those who know more also know more about how much they know? The calibration of probability judgments. *Org. Behav. Hum. Perform.* 16:1–12
- Lichtenstein S, Slovic P. 1973. Response-induced reversals of preferences in gambling: an extended replication in Las Vegas. *J. Exp. Psychol.* 101:16–20
- Lichtenstein S, Slovic P, Fischhoff B, Layman M, Combs B. 1978. Judged frequency of lethal events. *J. Exp. Psychol. Hum. Learn. Mem.* 4:551–78
- Loewenstein G, Elster J, eds. 1992. *Choice Over Time*. New York: Russell Sage Found.
- Loewenstein GF, Prelec D. 1993. Preferences for sequences of outcomes. *Psychol. Rev.* 100:91–108
- Loewenstein GF, Weber E, Hsee CK, Welch N. 2001. Risk as feelings. *Psychol. Bull.* 127:267–86
- Lopes LL, Oden GC. 1991. The rationality of intelligence. In *Probability and Rationality: Studies on L. Jonathan Cohen's Philosophy of Science*, ed. E Eels, T Maruszewski, pp. 199–223. Amsterdam: Editions Rodopi
- Luce RD, Fishburn PC. 1991. Rank- and sign-dependent linear utility models for finite first-order gambles. *J. Risk Uncertain.* 4:29–59
- Luce RD, Raiffa H. 1957. *Games and Decisions*. New York: Wiley
- Macdonald RR. 1986. Credible conceptions and implausible probabilities. *Br. J. Math. Stat. Psychol.* 39:15–27
- Machina M. 1982. "Expected utility" analysis without the independence axiom. *Econometrica* 50:227–324
- Manktelow K. 1999. *Reasoning and Thinking*. Hove, UK: Psychology Press
- March J. 1978. Bounded rationality, ambiguity and the engineering of choice. *Bell J. Econ.* 9:587–608
- Margolis H. 1987. *Patterns, Thinking, and Cognition: A Theory of Judgment*. Chicago: Univ. Chicago Press
- Mather M, Shafir E, Johnson MK. 2000. Misremembrance of options past: source monitoring and choice. *Psychol. Sci.* 11:132–38
- McNeil BJ, Pauker SG, Sox HC, Tversky A. 1982. On the elicitation of preferences for alternative therapies. *N. Engl. J. Med.* 306:1259–62
- Mellers BA, Schwartz A, Cooke ADJ. 1998. Judgment and decision making. *Annu. Rev. Psychol.* 49:447–77
- Mellers BA, Schwartz A, Ho K, Ritov I. 1997. Decision affect theory: emotional reactions to the outcomes of risky options. *Psychol. Sci.* 8:423–29
- Miller PM, Fagley NS. 1991. The effects of framing, problem variations, and providing rationale on choice. *Pers. Soc. Psychol. Bull.* 17:517–22
- Morier DM, Borgida E. 1984. The conjunction fallacy: a task specific phenomenon? *Pers. Soc. Psychol. Bull.* 10:243–52
- Neale MA, Northcraft GB. 1986. Experts, amateurs, and refrigerators: comparing expert and amateur negotiators in a novel task. *Org. Behav. Hum. Decis. Process.* 38:305–17
- Oakhill J, Garnham A. 1993. On theories of belief bias in syllogistic reasoning. *Cognition* 46:87–92
- Oaksford M, Chater N. 1996. Rational explanation of the selection task. *Psychol. Rev.* 103:381–91
- Osherson DN. 1995. Probability judgment. See Smith & Osherson 1995, pp. 35–75
- Osherson DN, Shafir E, Smith EE. 1994. Extracting the coherent core of human probability judgment. *Cognition* 50:299–313
- Payne JW, Bettman JR, Johnson EJ. 1993. *The Adaptive Decision Maker*. Cambridge: Cambridge Univ. Press

- Pearl J. 1988. *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference*. San Mateo, CA: Morgan Kaufman
- Petty RE, Wegener DT. 1999. The elaboration likelihood model: current status and controversies. See Chaiken & Trope 1999, pp. 37–72
- Politzer G, Noveck IA. 1991. Are conjunction rule violations the result of conversational rule violations? *J. Psycholinguist. Res.* 20:83–103
- Prelec D. 2000. Compound invariant weighting functions in prospect theory. See Kahneman & Tversky 2000, pp. 67–92
- Pulford BD, Colman AM. 1996. Overconfidence, base rates and outcome positivity/negativity of predicted events. *Br. J. Psychol.* 87:431–45
- Quattrone G, Tversky A. 1984. Causal versus diagnostic contingencies: On self-deception and on the voter's illusion. *J. Pers. Soc. Psychol.* 46:237–48
- Rabin M. 1998. Psychology and economics. *J. Econ. Lit.* 36:11–46
- Redelmeier DA, Shafir E. 1995. Medical decision making in situations that offer multiple alternatives. *JAMA* 273:302–5
- Redelmeier DA, Shafir E, Aujla P. 2001. The beguiling pursuit of more information. *Med. Decis. Mak.* In press
- Redelmeier DA, Tversky A. 1990. Discrepancy between medical decisions for individual patients and for groups. *N. Engl. J. Med.* 322:1162–64
- Reed S. 1993. Imagery and discovery. In *Imagery, Creativity, and Discovery: A Cognitive Perspective*, ed. B Roskos-Ewoldson, MJ Intons-Peterson, R Anderson, pp. 287–312. New York: North-Holland
- Resnik MD. 1987. *Choices: An Introduction to Decision Theory*. Minneapolis: Univ. Minn. Press
- Rips LJ. 1994. *The Psychology of Proof*. Cambridge, MA: MIT Press
- Ross SM. 1997. *A First Course in Probability*. Upper Saddle River, NJ: Prentice Hall. 5th ed.
- Rottenstreich Y, Hsee CK. 2001. Money, kisses, and electric shocks: on the affective psychology of risk. *Psychol. Sci.* 12:185–90
- Rottenstreich Y, Tversky A. 1997. Unpacking, repacking, and anchoring: advances in support theory. *Psychol. Rev.* 104:406–15
- Russo JE, Doshier BA. 1983. Strategies for multiattribute binary choice. *J. Exp. Psychol. Learn. Mem. Cogn.* 9:676–96
- Samuelson W, Zeckhauser R. 1988. Status quo bias in decision making. *J. Risk Uncertain.* 1:7–59
- Schkade DA, Kahneman D. 1998. Does living in California make people happy? A focusing illusion in judgments of life satisfaction. *Psychol. Sci.* 9:340–46
- Schwarz N. 1996. *Cognition and Communication: Judgmental Biases, Research Methods, and the Logic of Conversation*. Mahwah, NJ: Erlbaum
- Schwarz N, Clore GL. 1983. Mood, misattribution, and judgments of well-being: informative and directive functions of affective states. *J. Pers. Soc. Psychol.* 45:513–23
- Schwarz N, Strack F, Hilton D, Naderer G. 1991. Base rates, representativeness, and the logic of conversation: the contextual relevance of “irrelevant” information. *Soc. Cogn.* 9:67–84
- Sen A. 1993. Internal consistency of choice. *Econometrica* 61:495–521
- Shafir E. 1993. Intuitions about rationality and cognition. In *Rationality: Psychological and Philosophical Perspectives*, ed. KI Manktelow, DE Over, pp. 260–83. Florence, KY: Taylor & Francis
- Shafir E. 1995. Compatibility in cognition and decision making. *Psychol. Learn. Motiv.* 32:247–74
- Shafir E, Osherson DN, Smith EE. 1993a. The advantage model: a comparative theory of evaluation and choice under risk. *Org. Behav. Hum. Decis. Process.* 55:325–78
- Shafir E, Simonson I, Tversky A. 1993b. Reason-based choice. *Cognition* 49:11–36
- Shafir E, Tversky A. 1995. Decision making. See Smith & Osherson 1995, pp. 77–100
- Shiffrin RM, Schneider W. 1977. Controlled

- and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychol. Rev.* 84:127–90
- Sieck W, Yates JF. 1997. Exposition effects on decision making: choice and confidence in choice. *Org. Behav. Hum. Decis. Process.* 70:207–19
- Simon HA. 1955. A behavioral model of rational choice. *Q. J. Econ.* 69:99–118
- Simon HA. 1978. Rationality as process and as product of thought. *J. Am. Econ. Assoc.* 68:1–16
- Simonson I. 1990. The effect of purchase quantity and timing on variety seeking behavior. *J. Mark. Res.* 27:150–62
- Simonson I, Tversky A. 1992. Choice in context: tradeoff contrast and extremeness aversion. *J. Mark. Res.* 29:281–95
- Slooman SA. 1996. The empirical case for two systems of reasoning. *Psychol. Bull.* 119:3–22
- Slovic P, Finucane M, Peters E, MacGregor DG. 2001. The affect heuristic. See Gilovich et al. 2001. In press
- Slovic P, Griffin D, Tversky A. 1990. Compatibility effects in judgment and choice. In *Insights in Decision Making: Theory and Applications*, ed. R Hogarth, pp. 5–27. Chicago: Univ. Chicago Press
- Slovic P, Lichtenstein S. 1983. Preference reversals: a broader perspective. *Am. Econ. Rev.* 73:596–605
- Slugoski BR, Wilson AE. 1998. Contribution of conversation skills to the production of judgmental errors. *Eur. J. Soc. Psychol.* 28:575–601
- Smith EE, Osherson DN, eds. 1995. *Thinking: An Invitation to Cognitive Science*, Vol. 3. Cambridge, MA: MIT Press. 2nd ed.
- Smith SM, Levin IP. 1996. Need for cognition and choice framing effects. *J. Behav. Decis. Mak.* 9:283–90
- Stalnaker RC. 1984. *Inquiry*. Cambridge, MA: MIT Press
- Stanovich KE. 1999. *Who is Rational? Studies of Individual Differences in Reasoning*. Mahwah, NJ: Erlbaum
- Stanovich KE, West RF. 1998a. Cognitive ability and variation in selection task performance. *Think. Reasoning* 4:193–230
- Stanovich KE, West RF. 1998b. Individual differences in framing and conjunction effects. *Think. Reasoning* 4:289–317
- Stanovich KE, West RF. 1998c. Individual differences in rational thought. *J. Exp. Psychol. Gen.* 127:161–88
- Stanovich KE, West RF. 1999. Discrepancies between normative and descriptive models of decision making and the understanding/acceptance principle. *Cogn. Psychol.* 38:349–85
- Stanovich KE, West RF. 2000. Individual differences in reasoning: implications for the rationality debate? *Behav. Brain Sci.* 23:645–726
- Stein E. 1996. *Without Good Reason: The Rationality Debate in Philosophy and Cognitive Science*. New York: Oxford Univ. Press
- Stich SP. 1990. *The Fragmentation of Reason: Preface to a Pragmatic Theory of Cognitive Evaluation*. Cambridge, MA: MIT Press
- Sunstein CR, ed. 2000. *Behavioral Law and Economics*. Cambridge: Cambridge Univ. Press
- Swets JA, Dawes RM, Monahan J. 2000. Psychological science can improve diagnostic decisions. *Psychol. Sci. Public Interest* 1:1–26
- Takemura K. 1993. The effect of decision frame and decision justification on risky choice. *Jpn. Psychol. Res.* 35:36–40
- Takemura K. 1994. Influence of elaboration on the framing of decisions. *J. Psychol.* 128:33–39
- Tetlock PE. 1992. The impact of accountability on judgment and choice: toward a social contingency model. In *Advances in Experimental Social Psychology*, ed. MP Zanna, 25:331–76. New York: Academic
- Thaler RH. 1992. *The Winner's Curse: Paradoxes and Anomalies of Economic Life*. New York: Free Press
- Thaler RH. 1993. *Advances in Behavioral Finance*. New York: Russell Sage Found.
- Trope Y, Gaunt R. 1999. A dual-process model

- of overconfident attributional inferences. See Chaiken & Trope 1999, pp. 161–78
- Tversky A. 1972. Elimination by aspects: a theory of choice. *Psychol. Rev.* 79:281–99
- Tversky A. 1975. A critique of expected utility theory: descriptive and normative considerations. *Erkenntnis* 9:163–73
- Tversky A, Kahneman D. 1973. Availability: a heuristic for judging frequency and probability. *Cogn. Psychol.* 5:207–32
- Tversky A, Kahneman D. 1974. Judgment under uncertainty: heuristics and biases. *Science* 185:1124–31
- Tversky A, Kahneman D. 1981. The framing of decisions and psychology of choice. *Science* 211:453–58
- Tversky A, Kahneman D. 1983. Extensional vs. intuitive reasoning: the conjunction fallacy in probability judgment. *Psychol. Rev.* 90:293–315
- Tversky A, Kahneman D. 1986. Rational choice and the framing of decisions. *J. Bus.* 59:251–78
- Tversky A, Kahneman D. 1991. Loss aversion in riskless choice: a reference dependent model. *Q. J. Econ.* 106:1039–61
- Tversky A, Kahneman D. 1992. Advances in prospect theory: cumulative representation of uncertainty. *J. Risk Uncertain.* 5:297–323
- Tversky A, Koehler DJ. 1994. Support theory: a nonextensional representation of subjective probability. *Psychol. Rev.* 101:547–67
- Tversky A, Sattath S, Slovic P. 1988. Contingent weighting in judgment and choice. *Psychol. Rev.* 95:371–84
- Tversky A, Shafir E. 1992a. Choice under conflict: the dynamics of deferred decision. *Psychol. Sci.* 3:358–61
- Tversky A, Shafir E. 1992b. The disjunction effect in choice under uncertainty. *Psychol. Sci.* 3:305–9
- Tversky A, Simonson I. 1993. Context dependent preferences: the relative advantage model. *Manage. Sci.* 39:1179–89
- Tversky A, Slovic P, Kahneman D. 1990. The causes of preference reversal. *Am. Econ. Rev.* 80:204–17
- Tversky A, Wakker P. 1995. Risk attitudes and decision weights. *Econometrica* 63:1255–80
- Vallone RP, Griffin DW, Lin S, Ross L. 1990. Overconfident prediction of future actions and outcomes by self and others. *J. Pers. Soc. Psychol.* 58:568–81
- Van Boven L, Dunning D, Loewenstein G. 2000. Egocentric empathy gaps between owners and buyers: misperceptions of the endowment effect. *J. Pers. Soc. Psychol.* 79:66–76
- von Mises R. 1957. *Probability, Statistics, and Truth*. New York: Dover
- von Winterfeld D, Edwards W. 1986. *Decision Analysis and Behavioral Research*. Cambridge: Cambridge Univ. Press
- Wason PC. 1966. Reasoning. In *New Horizons in Psychology 1*, ed. B Foss, pp. 135–51. Harmondsworth, UK: Penguin
- Wetherick NE. 1971. Representativeness in a reasoning problem: a reply to Shapiro. *Bull. Br. Psychol. Soc.* 24:213–14
- Wilson TD, Houston CE, Etling KM, Brekke N. 1996. A new look at anchoring effects: basic anchoring and its antecedents. *J. Exp. Psychol. Gen.* 125:387–402
- Wilson TD, Wheatley T, Meyers JM, Gilbert DT, Axsom D. 2000. Focalism: a source of durability bias in affective forecasting. *J. Pers. Soc. Psychol.* 78:821–36
- Wright WF, Anderson U. 1989. Effects of situation familiarity and financial incentives on use of the anchoring and adjustment heuristic for probability assessment. *Org. Behav. Hum. Decis. Process.* 44:68–82
- Yates JF. 1990. *Judgment and Decision Making*. Englewood Cliffs, NJ: Prentice-Hall
- Zajonc RB. 1980. Feeling and thinking: preferences need no inferences. *Am. Psychol.* 35:151–75