Mindful Judgment and Decision Making

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Abstract

A full range of psychological processes has been put into play to explain judgment and choice phenomena. Complementing work on attention, information integration, and learning, decision research over the past 10 years has also examined the effects of goals, mental representation, and memory processes. In addition to deliberative processes, automatic processes have gotten closer attention, and the emotions revolution has put affective processes on a footing equal to cognitive ones. Psychological process models provide natural predictions about individual differences and lifespan changes and integrate across judgment and decision making (JDM) phenomena. "Mindful" JDM research leverages our knowledge about psychological processes into causal explanations for important judgment and choice regularities, emphasizing the adaptive use of an abundance of processing alternatives. Such explanations supplement and support existing mathematical descriptions of phenomena such as loss aversion or hyperbolic discounting. Unlike such descriptions, they also provide entry points for interventions designed to help people overcome judgments or choices considered undesirable.

Contents

INTRODUCTION

Since its origins in the 1950s, judgment and decision making (JDM) research has been dominated by mathematical functional relationship models that were its point of departure in the form of normative models. This focus on economics and statistics may have led JDM research to underutilize the insights and methods of psychology. Aided by the recent arrival of neuroscience methodologies to complement behavioral research, the field has started to realize, however, that the brain that decides how to invest pension money and what car to buy is the same brain that also learns to recognize and categorize sounds and faces, resolves perceptual conflicts, acquires motor skills such as those used in playing tennis, and remembers (or fails to remember) episodic and semantic information. In this review, we make a strong case for the utility of this realization.

JDM: judgment and decision making

JDM reviews are often structured by task categories, with section headings such as "preferences," "beliefs," and "decisions under risk and uncertainty" (Payne et al. 1992), and "risky choice," "intertemporal choice," and "social decisions" (Loewenstein et al. 2007). In contrast, our review employs headings that might be found in a cognitive psychology textbook. It capitalizes on the 50 years of research on cognitive and motivational processes that have followed Simon's (1957) depiction of human decision makers as finite-capacity information processors and decision satisficers. Attentional (in particular, perceptual) and learning processes have a longer history of consideration, with phenomena such as "diminishing sensitivity of outcomes" or "reference point encoding" for perception and the "illusion of validity" for learning. Affective, memory, and prediction processes have only more recently emerged as explanations of judgment and choice phenomena.

We retain some task category distinctions to organize specific content where appropriate. Thus, we distinguish between preference and inference. Preferences involve value judgments and are therefore subjective, such as deciding how much to charge for an item on eBay. Inferences are about beliefs, such as the judged likelihood that a political candidate will win the next election, and typically have objectively verifiable answers. Although this distinction reflects tradition, it may not reflect psychological reality. Preferences and inferences seem to draw on the same cognitive processes.

Our ability to organize our review by psychological processes is a sign of the growing

maturity of the field. JDM research no longer simply generates a growing list of phenomena that show deviations from the predictions of normative models. Instead, it has been developing and testing hypotheses about the psychological processes that give rise to judgments and choices and about the mental representations used by these processes. Although the number of JDM articles in major social psychology journals remained constant over the past 10 years, the number of JDM articles in major cognitive psychology journals increased by 50% over that period, reflecting the increased interest in integrating judgment and choice phenomena with the frameworks of hot and cold cognition.

New tools have undoubtedly contributed to this trend. This includes functional imaging and other neural and physiological recordings, process tracing tools (see sidebar Process Models and Process Tracing), and, increasingly, modeling tools such as mediation (Shrout & Bolger 2002) and multilevel analysis (Gelman & Hill 2007). A focus on psychological mechanisms has guided the decomposition of JDM task behavior into contributing cognitive processes and their variation across groups (Busemeyer & Diederich 2002, Stout et al. 2004, Wallsten et al. 2005, Yechiam et al. 2005). An increased focus on individual differences has been a noticeable feature of behavioral decision research over the past decade. Increased use of Web-based experimentation (Birnbaum & Bahra 2007) allows access to respondents with much broader and representative variation on demographic and cognitive variables, with new insights about individual, group, and life-span differences on JDM tasks, topics that are discussed in the second section of our review. More affordable genotyping has led to examinations of the heritability of economic traits like trust (Cesarini et al. 2007).

JDM research attracts public and media attention because it addresses real-world phenomena, from myopic dietary decisions to excessive stock market trading. Policy makers have increasingly utilized JDM theory and results when designing or changing institutions (Shafir 2008), the topic of our last major section. The recognition that preferences are typically constructed rather than stored and retrieved (Lichtenstein & Slovic 2006) may be psychology's most successful export to behavioral economics and the policy community and illustrates the utility of psychological process explanations. We now know how, and increasingly why, characteristics of choice options and task guide attention, and how internal memory or external information search and option comparison affect choice in path-dependent ways. This not only explains apparent inconsistencies in choice, but also provides insights and recipes for decision aiding and interventions, including the design of decision environments that nudge people to construct their preferences in ways they will not regret after the fact (Thaler & Sunstein 2008).

Psychological process explanations cast light on areas obscured in the shadows of statistical decision-process approaches. For example, years of work with Egon Brunswik's lens model, which provided valuable insights into the

PROCESS MODELS AND PROCESS TRACING

Early models in decision research attempted to explain changes in judgments or decisions (the "output") as a result of changes in information considered (the "inputs") using tools such as regression and analysis of variance. This approach is problematic because it considers only a subset of observable behavior and because different models can predict one set of outputs from a given set of inputs. Process models help because they consider more variables and add multiple constraints. By virtue of hypothesizing a series of psychological processes that precede a judgment or choice, they make predictions about intermediate states of the decision maker, between the start and end of the decision ("What external information is sought out? What facts are recalled from memory?"). Process models also make predictions about the temporal order of these states ("What will a decision maker think about first, second, etc.?"). Process data are the data used to test hypotheses about these intervening processes and intermediate states. They include functional imaging and other measures of localized brain activation, response times, verbal protocols, eye-movement tracking, and other information-acquisition tools (see **www.mouselabweb.org**).

Preferences: in economics, inferred from choices and assumed to reflect utilities. In psychology, thought to be constructed in order to make a choice

Inferences: decision makers' judgments about the world using logic and often imperfect and uncertain information

performance of human decision makers, may have hidden the important distinction between automatic and deliberative (controlled) processes and their properties (Schneider & Chein 2003). Process explanations also serve an integrative function by explaining multiple phenomena, providing an organizing principle for a field criticized for being long on effects and short on unifying explanations. Judgments and choices typically engage multiple psychological processes, from attention-guided encoding and evaluation, to retrieval of task-relevant information from memory or external sources, prediction, response, and postdecision evaluation of consequences and resulting updating. Different tasks involve these processes to different degrees. For example, attention accounts for a larger proportion of response variance in decisions from description, where the decision maker is explicitly provided with all relevant information in numeric or graphic form. In contrast, memory and learning will be more important in decisions from experience, where information about outcomes and their likelihood is acquired by trial and error sampling of choice options over time (see Hertwig et al. 2004). Similarly, affective processes are more important in dynamic decisions under uncertainty, whereas analytic evaluations play a larger role in static risky decisions (Figner et al. 2008).

The last comprehensive Annual Review article on JDM was published more than 10 years ago (Mellers et al. 1998). Two reviews since then have addressed special topics, namely rationality (Shafir & LeBoeuf 2002) and unsolved problems in decision research (Hastie 2001). Given this time span between JDM articles, our review had to be extremely selective. Our mandate, to review research on cognitive processes in judgment and choice, necessitated the omission of papers that describe JDM phenomena without emphasizing psychological process interpretations. We also had to limit the scope of psychological processes covered. With a few exceptions, we omitted very basic perceptual processes (e.g., categorization) and processes that go beyond the individual (e.g., group judgments and decisions; interdependent, competitive, and strategic decisions; advice giving; social judgments; information aggregations; and prediction markets). We were unable to go beyond judgment and choice processes, not covering problem solving, reasoning, or positive psychology. The burgeoning field of neuroeconomics recently received its own review (Loewenstein et al. 2007). When multiple papers could have been cited for a given point, we restricted ourselves to the most important, innovative, or comprehensive examples, and omitted citations for classic phenomena.

ATTENTION

Decision makers face a wealth of potentially relevant information in the external environment and memory. Given the processing limitations of *Homo sapiens*, selectivity is a central component of goal-directed behavior. Selective attention operates at very basic levels of perceptual identification (Lachter et al. 2004). It also operates at higher cognitive levels, including the initial perception of the situation and assessment of the task at hand (framing, goal elicitation), evidence accumulation (which can be external or internal, and usually is a combination of the two), and judgment or choice (determining cutoffs or decision rules).

A focus on attention as a finite resource, requiring selectivity, goes back to the beginnings of scientific psychology. William James in 1890 considered attention a necessary condition for subsequent memory, distinguished between voluntary and nonvoluntary attention, and suggested the use of eye movements to track attentional focus. More recently, Daniel Kahneman (1973) summarized what was known about attention during the postbehaviorist period when attention was used as a "label for some of the internal mechanisms that determine the significance of stimuli" (p. 2). Kahneman emphasized capacity limitations and the selective aspect of attention and distinguished between two determinants, momentary (voluntary) task intentions and more enduring dispositions such as the (involuntary) orienting

response to novel stimuli. Herbert Simon (1978) identified conscious attention as a scarce resource for decision makers in the year of his Nobel prize; Kahneman's Nobel lecture (2003) reiterates that this scarce resource needs to be allocated wisely and points to automatic (orienting) processes and fast emotional reactions as means to that end.

Exogenous Influences

Orienting responses. Some features of the environment attract attention because responding to them has survival value. Changes in the environment, and especially the appearance of novel stimuli, introduce the possibility of opportunity and/or threat. Constant exposure to a stimulus leads to habituation, i.e., reduced responding, as things not previously responded to are likely to be neither dangerous nor promising. On the other hand, a change in the environment results in dishabituation and an orienting response (Posner & Rothbart 2007).

As a result of the orienting response to changes in the environment, things that vary automatically attract and maintain attention. A siren that wails will attract attention longer than a siren that operates at a constant frequency. This has implications for a wide range of issues, from research design to human factors and institutional design, with salient continuous changes in the level of key decision variables as a recipe for keeping people's attention on the task, a manipulation perfected by video games. Arguments by Birnbaum (1983) about the consequences of within- versus between-subject manipulations of base rates have recently been revived in the context of quantity (in)sensitivity in protected value tradeoffs. Bartels & Medin (2007) reconcile conflicting results by showing that between-subject designs lead to quantity insensitivity (e.g., the same willingness to pay to restore the pH level of one lake or of ten lakes) (Baron & Ritov 2004), whereas within-subject designs, which attract attention to variation in quantity, show sensitivity to the variable (Connolly & Reb 2003).

Task characteristics. In the same spirit of integrating across apparently contradictory research results, a range of JDM tasks and context characteristics have been examined for their effect of guiding attention and thus decision weight to different outcome dimensions. Violations of procedure invariance are one of the most vexing cases of deviation from normative models of preference. Selling prices typically exceed buying prices by a factor of two, even when strategic misrepresentation is eliminated, and discounting of future benefits is much steeper when people are asked to delay rather than accelerate consumption (Kahneman & Tversky 2000). Below, we review information-recruitment mechanisms that explain how the direction of an economic transactions (e.g., acquiring or giving up ownership; switching from immediate to delayed consumption or vice versa) can affect valuation. Relating such valuation asymmetries to attentional processes, Carmon & Ariely (2000) show that decision makers focus their attention on the foregone, i.e., the status quo and its characteristics attract more attention and thus importance and decision weight than do other choice options.

Judgment versus choice. It has long been known that judgment versus choice tasks can direct attention to different characteristics of choice options, from preference reversal studies of risky decisions in the 1970s to the theory of task-contingent weighting of multiattribute choice (see Lichtenstein & Slovic 2006). Editing operations cancel out common outcomes for choices but cannot do so for judgments, with resulting differences in attentional allocation and information use that translate into differences in preference. Consumer purchases are typically the result of choice from among multiple alternatives, where alignable features receive greater attention, whereas postpurchase consumer satisfaction is the result of judging the product in isolation, where features that are easily evaluated in an absolute sense receive greater attention (Hsee & Zhang 2004). Many task-detail-induced inconsistencies in judgment and choice can be explained by differences in attentional

PT: prospect theory

Beta-delta model: explains greater discounting of future outcomes when immediate rewards are available than when all rewards are in the future by an exponential delta process that always operates and an additional exponential beta process that only operates when immediate rewards are present

focus, although the inconsistencies are not exclusively due to attentional mechanisms. Most stable JDM phenomena such as preference reversals are probably stable because they are multiply determined.

Description of choice options. The way in which information about choice options is communicated to decision makers influences preference construction through selective attention, even though variants may be informationally equivalent. One of these ways is the order in which options are presented. Candidate name order on ballots, for example, has been shown to influence preference and voting sufficiently to determine election results (Krosnick et al. 2004). Options encountered first capture attention, leading to reference-dependent subsequent evaluations and comparisons (Kahneman 2003). In decisions from description, some outcome dimension values (namely certainty on the probability dimension and immediacy on the delay dimension) are given special status, i.e., extra attention and decision weight of a more categorical than continuous nature, as captured by prospect theory's (PT) decision weight function and Laibson's (1997) beta-delta model of time discounting. Weber & Chapman (2005) show that certainty and immediacy are connected, in that adding delay "undoes" the special preference given to certainty, and adding uncertainty removes the special preference given to immediacy.

Process of knowledge provision. In decisions from description, attention is shared between outcome and probability information, which are both explicitly provided. In decisions from experience, the series of sequentially experienced outcomes focuses attention on this dimension, with more recent outcomes looming larger (Weber et al. 2004). The emergent evidence that rare events get underweighted in decisions from experience but overweighted in decisions from description, as captured by PT, can be explained by differences in attentional focus during information acquisition (Erev et al. 2008), because attention directed by both external and internal factors has been shown to translate into decision weight (Weber & Kirsner 1997).

Endogenous Influences

In addition to external influences, the internal state of the decision maker guides attention. Decision makers generally have more control over their internal states, thus allowing for more voluntary allocations of attention.

Goals. JDM research over the period of our review has started to interpret behavior in terms of goals and plans rather than (or in addition to) utilities (Krantz & Kunreuther 2007). Survival and economic well-being dictate that material goals play an important role in people's plans and decisions. Material goals are responsible for the effectiveness of financial incentives in shaping behavior. However, people harbor many other goals, some of which relate to nonmaterial dimensions of the choices made [e.g., being defensible (Lerner & Tetlock 1999)], whereas others relate to the nature of the decision process [e.g., wanting a procedurally just process (Tyler 2005) or a process that feels right (Higgins 2005)]. With multiple and often conflicting goals in play, selective attention to different subsets of goals has been shown to influence how a decision is made and what is selected (Krantz & Kunreuther 2007). A range of factors has been shown to situationally activate goals or chronically elevate their accessibility, including cultural values of the decision maker (Weber et al. 2005a), the content domain of the decision, e.g., risky choices about course grades versus stock investments (Rettinger & Hastie 2001), and task characteristics such as required accountability (Tetlock 2002). Activated goals determine whether the decision rules used are deontological ("What is right?") versus consequentialist ("What has the best outcomes?") versus affective ("What feels right?") (Bartels & Medin 2007). Ariely et al. (2000) point to the importance of goals in the context of choices between different streams of experience over time. Similar to the discussion above about quantity (in)sensitivity in the context of

protected value tradeoffs, people are more or less duration sensitive when evaluating experiences over time as a function of how their attention is focused by how they report their experiences and why.

Affect as spotlight. Emotions experienced by the decision maker, in addition to the many cognitive factors mentioned above, focus attention on features of the environment that matter for emotion-appropriate action tendencies. Mood-congruent perception focuses attention on either upside opportunity or downside risk (Chou et al. 2007). Feelings of fear or worry focus attention on the source of the apparent threat and ready flight responses (Loewenstein et al. 2001). Feelings of anger focus attention on information about motives and responsibility and make decision makers eager to act and punish. Sadness elicits a desire to change one's state, resulting in reduced selling and inflated buying prices, whereas disgust triggers a desire to purge or acquire less, with the opposite effect on willingness to pay (Lerner et al. 2004).

ENCODING AND EVALUATION

One clear finding from behavioral decision research is that information is acquired by decision makers in ways not addressed by normative models. Goal-relevant and context-sensitive encoding of information is one of the ways in which people execute their task with minimal effort and, perhaps, maximal satisfaction. One important distinction to make is between information obtained from a search of external sources (external search; e.g., when choosing a cereal by studying product information in a supermarket aisle) versus information retrieved from memory (internal search; e.g., when retrieving options about which route to take on a drive home). Most decisions involve both kinds of search. The cereal choice probably involves recalling how much the previously purchased brand was enjoyed, and the choice of a route home uses external retrieval cues and information about traffic congestion. The distinction matters, however, because the properties of external search (reviewed in this section) are demonstrably different from the properties of retrieval from memory (reviewed in the next section on Memory Storage and Retrieval).

Evaluation is Relative

Outcomes. The humorist Thurber was once asked how he liked his new wife. His response "Compared to what?" reflects one of prospect theory's (Kahneman & Tversky 1979) major insights, namely that evaluation is relative. This insight continues to gather support, albeit in more complex ways than formalized by PT. Since neurons encode changes in stimulation (rather than absolute levels), absolute judgments on any dimension are much more difficult than relative judgments. The list of reference points used in relative evaluation continues to grow and includes other observed or counterfactual outcomes from the same or different choice alternatives, as well as expectations. For example, the range of options offered as potential certainty equivalents has been shown to affect people's valuation of gambles (Stewart et al. 2003). One important area for future research is to understand better the selection among reference points and how multiple reference points might be used.

Most discussions of relative evaluation have focused on the evaluation of a single outcome by comparing it to a reference point, typically by computing their difference in value. However, differences themselves may be in need of relative evaluation. If asked how good his $5000 salary increase was, Thurber probably would have also asked, "compared to what?" Gonzalez-Vallejo's (2002) proportional difference model is a stochastic model of choice that answers this question. Differences in attribute values of two choice options are normalized by dividing them by the best (for positive) or worst (for negative) possible outcome. These proportional differences are then integrated across attributes by a stochastic decision process, allowing the model to account for a broader range of choice patterns than other models (Gonzalez-Vallejo et al. 2003). Normalization

Variability or risk: the risk in risky choice options is introduced by not knowing what outcome will occur. In economics and finance, the variance of possible outcomes is used as a measure of risk

Expected value: the average outcome one gets from some risky choice; e.g., $50 is the expected value of a coin toss for $100 or $0 [$50 = 0.5($100) + 0.5($0)]

of outcome differences in ratio form also appears to hold for implicit evaluations of variability or risk. The coefficient of variation, defined as the standard deviation of possible choice outcomes divided by their expected value (i.e., risk per unit of return), predicts people's risky choices and risky foraging of animals far better than does the typical nonnormalized measures of variability or risk (standard deviation or variance) employed in finance (Weber et al. 2004).

The discriminability of differences is a central concern for relative evaluations. It lies at the root of Ernst Weber's 1834 basic law about the psychophysical coding of just-noticeable differences, which captures the observation that detectable increases in visual or auditory signal intensity are proportional to the starting value, i.e., need to be larger for larger starting values. Furlong & Opfer (2008) provide provocative evidence about the effect of outcome magnitude on the discriminability of differences. In their studies of humans and orangutans in the prisoners' dilemma game, changing the currency in which the usual payoffs for defection or cooperation are issued (for humans, dollar outcomes multiplied by 100 to produce outcomes in cents; for orangutans, grapes issued intact or cut into tiny pieces) increases the rate of cooperation, presumably because the difference in payoffs for defection over cooperation is less discriminable with the larger numeraires.

Probabilities. Traditionally, explicitly provided probability judgments of events were thought to reflect either a frequentist evaluation or an expression of a degree of belief. However, more recent formulations have posited transformations of explicitly provided outcome probabilities in choice into decision weights that are a function of the amount of attention paid to the different potential states of the world, which is affected by more than the states' likelihood of occurrence. Events may attract greater attention for perceptual and motivational reasons (Weber & Kirsner 1997). Thus, small-probability events may be overweighted by PT relative to their stated likelihood of occurrence because decision makers' attention is regressive. In other words, decision makers pay more equal attention to all possible outcomes than is warranted by their (typically unequal) probabilities, and decision makers linger at extreme outcomes to assess best- and worse-case scenarios. Rank-dependent models of risky choice have provided such a reinterpretation of the way in which explicitly stated probabilities are evaluated in choice. They also provide an alternative way to think about risk-averse or risk-seeking behaviors. In cumulative PT (Tversky & Kahneman 1992), the subjective weight given to a given outcome no longer is simply a nonlinear transformation of its objective probability of occurring, but also reflects the relative rank of the outcome in the distribution of possible outcomes. Cumulative PT is only one way in which the evaluation of outcome probabilities can depend on the position of the outcome in the configuration of outcomes (Lopes & Oden 1999). More complex ways, such as those in Birnbaum's transfer of attention model (Birnbaum 2005), have been shown to account for a broader range of choice phenomena. These attentional effects become even more important when choice options contain more than two outcomes or when the gambles are mixed (Luce 2000, Payne 2005).

Choice from External Search

Heuristics for risky choice. Brandstätter et al.'s (2006) priority heuristic (PH) tries to account for many phenomena in risky choice in simpler ways than do models that involve tradeoffs, such as PT. The model is noteworthy for making not just choice predictions, but also predictions about response times and information acquisition. The PH has been criticized for its use of discrete measures of error (Rieger & Wang 2008) and for making choice predictions that are not observed (Birnbaum 2008). Johnson et al. (2008) found that although some implications of the PH were supported, the critical test, namely that decision makers do not integrate probabilities and payoffs, were not borne out by process measures. Despite the mixed empirical support surrounding the

heuristic, the research exchange triggered by it demonstrates that process predictions and their tests can improve choice models.

Sampling and evaluation in external search. If we believe that decision makers often attend selectively to a subset of possible information, it is important to understand the properties of such samples, the processes used to produce them, and the consequences these samples have on decisions.

A class of what might be called middle-level sampling models ambitiously attempts to describe a large set of empirical regularities or stylized facts. Each model has its own set of assumptions about cognitive processes and representations and thus makes predictions not just for observed choices, but also for process measures such as response times (Ratcliff et al. 2006). Although these models share a concern with the accumulation of evidence via sampling, they emphasize different aspects of the decision process.

Prototypical of a class of models that could be characterized as stimulus sampling models are recent extensions of Busemeyer & Townsend's (1993) decision field theory (DFT) to multiattribute choice (Roe et al. 2001) and to models of value judgments as well as choice (Johnson & Busemeyer 2005). The key idea in DFT is that attributes of choice alternatives are repeatedly randomly sampled and that evidence accumulates over samples. This process of information retrieval, whether from the external environment or from memory, is assumed to be independent of the evaluation of the object, i.e., is not path dependent. When applied to choice, DFT posits a race between options, with each additional acquisition of evidence increasing or decreasing the valuation for an option, ending when the first option exceeds a preset threshold. In addition to having a closed-form mathematical formulation, DFT can also be expressed as a multilayer connectionist network and has been applied to explain context effects such as the similarity, attraction, and compromise effects (Roe et al. 2001). By adding a set of potential responses (in a comparison layer) to its neural network version, DFT can generate predictions for several preference reversals (Busemeyer & Diederich 2002). DFT (and its decomposition) has also provided a useful framework to analyze group differences on the Bechara gambling task, as described below. Computational considerations have led to a modification of DFT that incorporates loss aversion into the accumulation of evidence (Usher & McClelland 2004), thus extending stimulus sampling models to explain the endowment effect and other JDM phenomena attributed to loss aversion.

Decision field theory (DFT): a mathematical and process model suggesting that decisions are made by aggregating samples randomly drawn from the information available about a set of alternatives

Decision by sampling (Stewart et al. 2006), another mid-level model, is an interesting attempt to explain several stylized facts with two simple mechanisms: (*a*) value is constructed by simple ordinal comparisons between an object at hand and consecutive repeated samples of objects drawn from memory, and (*b*) the samples reflect the external ecological frequency of objects. Using archival data, these two assumptions are able to reproduce the PT value and probability weighting function and a time-discounting function that looks hyperbolic.

Decision by distortion. Stimulus sampling models typically assume samples that are unbiased reflections of the environment and are path-independent. In contrast, two streams of research suggest that choice involves a biased, and path-dependent, integration of information. Building on earlier ideas about constructed dominance by Montgomery and Svenson in the 1980s, Holyoak & Simon (1999) and Russo and colleagues (2000) posit that choices are speeded up and made with minimal regret by distorting the value of options to support early-emerging favorites. The existence of an early favorite leads to subsequent information being interpreted in a way that supports that favorite, bolstering its chances of being chosen (Simon et al. 2004), even for a single option (Bond et al. 2007). Simply being listed as the first option can cause this distortion of values and increase in choice (Russo et al. 2008), showing the influence of attentional focus on subsequent evaluation and choice.

Inferences from External Search

In contrast to mechanisms such as availability, which posit that biases in inference result from biased representations produced by recall, several researchers have argued that such biases can result from biased sampling of external information, either as a function of how the information is presented by the environment or by biases in a search on the part of the decision maker (Fiedler 2000). For example, the observer of a conversation, which provides a sampling of the beliefs of the two conversing parties, may get a biased sample of what the participants believe because a range of Gricean conversational rules apply restrictions (e.g., not repeating what was just said). As a result, Fiedler argues, the observer may well conclude that the conversation is more hostile than it really is. By arguing that the observer is insensitive to the bias in the observed sample of beliefs, Fiedler (2000) moves the origins of observed bias from the decision maker's memory (as in availability) to the environment, aided by the decision maker's lack of understanding the biased origin of the sample. Juslin et al. (2007) have applied very similar ideas to confidence judgments.

Goal and Framing Effects

McKenzie & Nelson (2008) suggest that different semantic frames that might be seen as logically equivalent (e.g., a glass being half full or half empty) linguistically transmit different information because different frames elicit different semantic associates. Fischer et al. (1999) similarly suggest that different response modes have different goals and that evaluation differs to accommodate those goals. For example, prominent attributes receive more weight in tasks whose goal is to differentiate among options than in tasks whose goal is to equate options.

MEMORY PROCESSES

Making decisions without recourse to relevant prior memories is a difficult task and is a topic that has long fascinated writers and filmmakers. Memory is necessary for our ability to learn and to draw on past experience to predict future desires, events, or responses to outcomes. Yet the connection between properties of memory and judgment and choice has previously been underexplored. During the past decade, memory considerations have played a more prominent role in explanations of JDM phenomena, attempting to leverage what we know about memory to provide insight into the processes underlying known decision phenomena (Reyna et al. 2003, Schneider 2003), but this is still a relatively underdeveloped area of behavioral decision research.

Memory Storage and Retrieval

Memory accessibility and priming. Seeing a stimulus results in a transient increase in accessibility of the representation of that stimulus and related concepts, a phenomenon called priming, with effects on subsequent memory access, i.e., shorter reaction times and greater likelihood of retrieval. Priming is widely used in social cognition, where primed attitudes and values shape behavior. Extending this paradigm, Mandel & Johnson (2002) demonstrated priming effects in multiattribute choice. In a consumer choice task, their selective priming of product attributes with appropriate wallpaper on the initial page of an online shop affected not only choice but also information search and use.

Memory is reactive. Unlike computer memory, human memory is changed by attempts at retrieval. Accessing memory both increases short-term accessibility and changes the long-term content of memory.

Short-term effects. Studies of anchoring suggest that priming memory accessibility, and consequently preference, can be changed by asking a prior question, even if the answer to this question should be irrelevant to subsequent tasks, such as using the last four digits of a social security number as an anchor for pricing a gamble

(Chapman & Johnson 1999). This effect was replicated with fine wine by Ariely et al. (2003), who also show that such accessibility-mediated anchoring effects are strong and robust and persist in the presence of significant accuracy incentives, experience, and market feedback. The selective accessibility model provides similar mechanisms and provides evidence that anchors make some information more accessible as measured by reaction times (Mussweiler & Strack 2001), though accessibility may not be sufficient to explain all anchoring effects (Epley & Gilovich 2001).

Long-term effects. Accessing information about possible choice options not only generates short-term changes in the accessibility of related information but also changes memory in a more permanent fashion, a phenomenon long recognized in social cognition. In the context of consumer choice and a line of research that goes back to the work on the self-correcting nature of errors of prediction, measuring the long-term effects of purchase intentions on memory has been shown to change subsequent purchases (Chandon et al. 2004).

Retrieval and preference construction. A recent perspective on preference construction, query theory (QT; Johnson et al. 2007), suggests that decision makers consult their memory (or external sources) with queries about the choice alternatives, in particular their merits or liabilities. QT assumes that most tasks suggest a natural way to the order in which queries are posed. When one class of components of a memory structure is queried, the accessibility of other components that could be response competitors is temporarily suppressed to minimize intrusions, but with consequences for the success of subsequent queries for which these components are legitimate responses. Memory inhibition as the result of prior recall of related and competing material is one of the oldest and most developed memory phenomena (Anderson & Neely 1996). Johnson et al. (2007) show that QT accounts for the endowment effect, under the assumption that sellers and buyers have different query orders, and they demonstrate the causal involvement of query order and memory inhibition by making the endowment effect disappear by switching the natural order of queries. Extending this paradigm, Weber et al. (2007) show that queries about reasons supporting immediate versus delayed consumption are issued in reverse order for intertemporal decisions about accelerating or delaying consumption, explaining the well-known result that people are much more impatient when delaying than when accelerating consumption. Explicitly prompting queries in the order opposite to the naturally occurring one again eliminates the effect. The task- and goal-specific distortions in balance of support that is generated by QT-predicted and empirically observed memory retrieval interference presumably have the same function (i.e., faster decisions with less postdecision regret) in decisions based on internal search that predecisional distortions (discussed in the previous section) have in decisions based on external search. Both predecisional distortion of external information and QT-related biased memory retrieval suggest that the process of preference or inference construction is characterized by systematic path dependency, contrary to the assumptions of most mathematical models of judgment and choice.

Consistent with a memory interference account, Danner et al. (2007) show that three or more retrievals of a specific means towards a goal will succeed in inhibiting competing means for the same goal. It is worth noting that this "discovery" in social cognition in the context of habit formation and goals-means networks coincides with experimental practice in proactive interference studies (e.g., Dougherty & Sprenger 2006). Thus, memory retrieval is one more way in which goals have been tied more closely to decision making over the past decade.

Query theory (QT): a process model of valuation describing how the order of retrievals from memory ("queries") play a role in judging the value of objects, emphasizing output interference

Memory and Inference

Memory and support theory. Support theory (ST), proposed by Tversky & Koehler (1994), models probability judgments as a

Luce's choice axiom: the probability of selecting one item over another from a pool of many items is a function of only the utilities of those two items and is not affected by the presence or absence of other items in the pool

Support theory: a model of inference about the probability of an event that uses the relative weight of what we know and can generate about the event in question (its "support") and compares it to what we know and can generate about all other possible events

RH: recognition heuristic

comparison of support for focal hypothesis A (s(A)) with support for a set of alternative hypotheses B (s(B)), in the form of a ratio familiar from Luce's choice axiom: $p(A,B) = s(A)/(s(A) + s(B)$. Support theory is a rational model in the sense that it assumes that set B includes only relevant alternative hypotheses, i.e., hypotheses that have some probability of occurring. Since competing hypotheses are often generated by associative memory processes from long-term memory (Dougherty & Hunter 2003), irrelevant alternative hypotheses (that have no possibility of occurring in the context of interest) may well be generated and may affect probability judgments by occupying valuable slots in limited-capacity working memory [referred to as inhibition failure by Dougherty & Sprenger (2006)]. Irrelevant alternatives in working memory may not be identified as irrelevant, referred to as discrimination failure by Dougherty & Sprenger (2006), who provide evidence for such failures using a proactive interference paradigm. A negative correlation exists between individual differences in working-memory capacity and degree of subadditivity of probability judgments. The judged probability of a focal event (e.g., rain) is larger when compared to the implicit disjunction (not rain) than when it is compared to the explicit disjunctions (e.g., sunshine, snow, cloudy, all other), suggesting that people with greater working-memory capacity are able to include more alternative hypotheses in the implicit disjunction condition (Dougherty & Hunter 2003). In combination, these and related studies suggest that augmentation of support theory with realistic assumptions about the retrieval and evaluation of alternative hypotheses can significantly increase its predictive accuracy. Dougherty & Sprenger (2006) also illustrate how measures of individual differences can help distinguish among hypothesized judgmental processes.

Memory-based heuristics for inference. In 1996, Gigerenzer and Goldstein suggested the take-the-best (TTB) strategy as both an accurate and easy procedure for inferences based on memory retrieval. TTB mimics what is known as a lexicographic decision rule in choice, suggesting that good inferences can be made by using the most diagnostic cue(s) that distinguish between two alternatives. Knowledge about cue diagnosticity depends, of course, on metacognitive insight about past inferential accuracy. Initial simulations showed surprising levels of performance for a process that uses such limited information. TTB performs particularly well when the distribution of cue validities is highly skewed. However, TTB is not the only heuristic that does well. Simulations show that heuristics that are even simpler than TTB can do quite well in the same environments (Hogarth & Karelaia 2007). Other simple heuristics do as well or better (Chater et al. 2003) in other environments. Examinations of TTB as a descriptive model of memory-based inference suggest that it is not universally used, but also not infrequently employed, describing between 20% and 72% of inferences (Broder & Gaissmaier 2007). More importantly, use of the strategy appears to vary in a way that is adaptive given the environment, with more-intelligent decisions makers being more adaptive (Broder 2003). New developments are models that integrate TTB and full information use along a continuum, specified by the amount of weight given to the comparison of different attributes (Lee & Cummins 2004), and generalizations that relax the assumption that decision makers know the exact cue weights (Bergert & Nosofsky 2007).

A similar story surrounds the recognition heuristic (RH), posited as a powerful rule for inference in cases in which only one of two provided comparison alternatives is recognized, and applied in tasks such as deciding which of two cities is larger (Goldstein & Gigerenzer 2002). Initial demonstrations showed good performance over a wide range of domains, but subsequent studies have delineated boundary conditions. In a paradigm that teases apart recognition and cue validity, Newell & Shanks (2004) show that RH is abandoned when recognition is not the most reliable cue. Similarly, the recognition heuristic is not used when recognition can be attributed to other causes (Oppenheimer 2003). Although it is clear that

recognition can be a useful tool in inference, the debate now seems to be whether recognition is always used as a first stage in inference (Pachur & Hertwig 2006) or whether recognition is simply one cue in inference that can be integrated (Richter & Spath 2006) but has no special status. In choice, recent work on decision modes (Weber et al. 2005a) identifies recognition as a decision mode that uses identification of a choice situation as a member of a class of situations for which a prescribed best action exists, following in the tradition of image theory by Lee Beach and work by James March in the early 1990s.

Work in inference seems to be reaching a conclusion similar to that of previous work in choice by Payne and colleagues (1992). The number of processes in the adaptive toolbox is large, and their use is adaptive to task characteristics. The interesting questions are how processing strategies are selected and when they succeed and fail. Answers to these questions will come from explicit models of strategy selection (Rieskamp & Otto 2006) and more formal and detailed models of the role of memory and forgetting in inference (Dougherty et al. 1999, Schooler & Hertwig 2005).

MULTIPLE INFORMATION PROCESSES

Normative JDM models have an appealing simplicity. With an axiomatic foundation, they employ a small number of primitives, abstract from content and context, and give rise to consistent judgments and decisions across situations. Initial attempts to make these models psychologically plausible and better able to describe observed judgment and choice patterns coincided with the cognitive revolution in psychology that used the digital computer as its metaphor for human information processing and contrasted algorithmic with heuristic solutions. Normative model modifications thus focused on cognitive shortcuts taken by limited-capacity information processors. This repertoire of alternative cognitive strategies was first investigated in the context of preference by Payne et al. (1992) and subsequently extended to inference tasks (Goldstein & Gigerenzer 2002). In the context of preference, affective processes have recently been added to the list of potentially adaptive strategies (Finucane et al. 2000, Luce et al. 2000).

The Emotions Revolution

Though successful in many ways, the cognitive revolution may have been too focused on analytic and computational processes. The emotions revolution of the past decade or so has tried to correct this overemphasis by documenting the prevalence of affective processes, depicting them as automatic and essentially effort-free inputs that orient and motivate adaptive behavior. Review articles that describe the role of emotions in risky choice and their effort-reducing potential (Finucane et al. 2000, Loewenstein et al. 2001) incorporate prior work on emotional priming by Johnson and Tversky in 1983 and on psychological risk dimensions (Slovic 1999). Following Peters et al. (2006a), we describe research on four functions of affect: as spotlight (discussed under Attention), information, common currency, and motivator.

Affective Processes

Affect as information. Emotions experienced while making a decision are incorporated as information into choices (Schwarz 2002). Positive and negative past associations with available choice outcomes thus contribute to new decisions. Loewenstein et al. (2001) distinguish between immediate emotions and anticipated/expected emotions. Immediate emotions, aroused either by task-relevant characteristics or incidentally, and their effect on judgment and choice are the topics of this section.

Choice-option–elicited immediate emotions are at the base of traditional economic interpretations of utility as emotional carriers of value. Positive emotions increase value and result in approach, whereas negative values decrease value and result in avoidance (see Affect as Motivator below). The Iowa gambling

task (Bechara et al. 1994) popularized the notion of a somatic marker that carries memories of the negative affect associated with losses in high-risk gambles; these memories prevent healthy respondents from choosing such gambles on subsequent trials. The absence of such affective information [initially demonstrated in frontal lobe patients and since then in other patient populations, including substance abusers (Stout et al. 2004)] is associated with performance deficits in the form of increased choices of disadvantageous risky gambles.

Incidental emotions (i.e., emotions unrelated to the judgment or decision at hand, typically elicited by a preceding event or activity) have also been shown to influence choice. Alice Isen's mood maintenance hypothesis from 1987 assumes that people in a good mood would like to maintain this pleasant state and thus try to avoid hard, analytic work and use cognitive shortcuts instead. Consistent with this hypothesis, Au et al. (2003) found that financial market traders traded differently when in a good or bad incidental mood (elicited by music). Good mood resulted in inferior performance and overconfidence, bad mood resulted in more accurate decisions and more conservative trading. Chou et al. (2007) compared mood maintenance to mood priming to explain patterns of risk taking in either a positive, negative, or neutral incidental mood, and found evidence mostly for mood priming (i.e., more risk taking in a happy mood and less in a sad mood) for both younger and older adults.

Incidental feelings influence judgments or choice also by being misattributed to having been elicited by the task at hand. Misattribution, an old experimental paradigm going back to Schwarz and Clore in 1983, is still in active use. Men were shown to misattribute their arousal after viewing photos of attractive females to arousal generated by the prospect of having to delay consumption in a subsequent intertemporal financial-choice task, and they therefore discounted future outcomes more strongly (Wilson & Daly 2004). Misattributions of the absence of fluency, the subjective feeling that forming a preference for a specific option is easy, as the result of incidental characteristics (a hard-to-read type font) have been shown to affects consumer decisions (Novemsky et al. 2007). We seem to have metacognitive awareness that these misattributions can occur, as evidenced by the fact that we use knowledge of other people's incidental mood states in strategically correct ways (Andrade & Ho 2007).

Affect as common currency. Interpretations of utility as the pleasure or pain associated with the experience of outcomes (experienced utility) go back to Bentham, predating the current economic interpretation of utility as inferred from choice (decision utility). Contextual effects on risky choice have been explained in decision affect theory as modifications of the emotional reactions to obtained outcomes as the result of pleasure or displeasure induced by relative comparisons between the obtained and counterfactual alternative outcomes (Mellers et al. 1999). In this sense, experienced emotions provide a common currency on which the effects of both different outcome dimensions and variations in decision context can be integrated. Decision affect theory provides a unifying framework that incorporates special cases of emotional reactions to counterfactual outcome comparisons such as regret or disappointment (Connolly & Zeelenberg 2002) or loss aversion in its interpretation as affective reaction (Lerner et al. 2004). To the extent that the output of multiple processing channels needs to be combined, an affective common currency seems to be a promising hypothesis.

Social psychological perspectives on JDM also rely on affect as a common currency. When people make a risky decision in a manner that fits their self-regulatory orientation (e.g., a promotion or prevention focus, which can be either chronic or situationally induced), they feel right about the process. This value from fit has been shown to transfer to their evaluation of the obtained outcome (Higgins 2005).

Affect as motivator. Just as preferences are constructed, so is affect. Affect construal theory

(Ellsworth & Scherer 2003) shows that the effect of affective reactions cannot be satisfactorily attributed to the emotions' valence and intensity, but rather is influenced by other situational appraisals. Emotions can be similar in valence and intensity (like fear versus anger) but result in very different judgments or choices because they are associated with different action tendencies. Thus, Lerner & Keltner (2001) show that fear increases risk estimates and risk-averse choices, whereas anger decreases risk estimates and increases risk-seeking choices. Similar results were found in a natural experiment, conducted after the 9/11 terrorist attack in the United States (Lerner et al. 2003). In a nationally representative sample of Americans, those who scored higher on an anxiety scale (fear) had greater perceptions of risk, and those who scored higher on a desire-for-vengeance scale (anger) had lower perceptions of risk up to 10 weeks after the attack. Gender differences in risk perception, with men perceiving fewer risks, were largely accounted for by gender differences in self-reported emotions. Emotions also affected endorsement of different terrorism policies.

Dual-Process Explanations

Dual-process models have a long history in the social sciences. Adam Smith argued that behavior was determined by the struggle between passions and an impartial spectator (Ashraf et al. 2005). More recent psychological models have distinguished between a rapid, automatic and effortless, associative, intuitive process (System 1), and a slower, rule-governed, analytic, deliberate and effortful process (System 2) (Kahneman 2003). Ferreira et al. (2006) provide experimental evidence for this dichotomy by varying processing goals, cognitive resources, priming, and formal training of respondents, and show that the automatic and controlled processes affected by these manipulations make independent contributions to judgments and choices under uncertainty. There is debate about the extent and way in which the two systems interact (Evans 2008, Keysers et al. 2008). Serial interventionist models put System 2 into a supervisory role because System 2 knows the analytic rules that the intuitive System 1 is prone to violate and thus can intervene to correct erroneous intuitive judgments (Kahneman 2003), but other relationships, including parallel-competitive horse-race models (Sloman 1996), need to be considered.

Valuation of risky options. Both cognitive (Johnson et al. 2007) and affective processes (Lerner et al. 2004) have been shown to influence people's evaluative judgments. Hsee & Rottenstreich (2004) contrast valuation by feeling and valuation by calculation. Emotional reactions are assumed to be far more binary (i.e., elicited or not) than analytic assessments of either value or likelihood, with the result that, for more emotionally charged choice options, we observe both greater scope insensitivity and a more highly nonlinear probability-weighting function.

Risk taking. Behavioral researchers have provided psychological generalizations of the normative model of finance, which assumes that the prices of risky investment options reflect a tradeoff between risk and return that are more affect based. In finance (e.g., the capital asset pricing model), both risk and return are assumed to be immutable statistical properties of the risky option, captured by the variance and expected value of the outcome distribution. Psychophysical risk-return models assume that perceptions of risk and return are psychological constructs that can vary between individuals and as a result of past experiences and decision content and context. Perceived benefits are often well predicted by analytic considerations such as expected returns based on past returns (Weber et al. 2005b), but they also vary as a function of interests or expertise (Hanoch et al. 2006). However, perceived risk is less predicted by analytic considerations (such as expected volatility as a function of past volatility) and more by affective reactions related to familiarity with the choice option (a domestic stock with high name recognition) (Weber et al.

2005b) or decision domain (Weber et al. 2002). Observed risk taking is the result of a long list of cognitive and affective evaluation and integration processes. For example, payoff sensitivity as well as health and social risk taking as measured by a recent domain-specific risk-taking scale (Weber et al. 2002) uniquely predict recreational drug use by college students (Pleskac 2008). Although some affective reactions and their effect on risk taking are objectively justifiable [e.g., the cushioning effect of financially supportive networks found in more collectivist cultures (Weber & Hsee 1998)], others are not (Slovic 1999).

Perceptions of risk and ambiguity also seem to mediate the effect of narrow versus broad choice bracketing (Read et al. 1999) on risk taking (Venkatraman et al. 2006). Two studies presented choice options in a segregated way (narrow bracketing) or aggregated way (broad bracketing). These studies found that perceived riskiness [which loaded on affective variables, such as worry and loss, as also found by Weber et al. (2005b)] and perceived ambiguity (which loaded on cognitive variables, such as uncertainty, lack of understanding, and information needs) were distinct factors that independently mediated the effect of presentation format on preference.

Iowa gambling task. The Iowa gambling task, mentioned above, assumes that somatic markers that carry memories of the negative affect associated with losses in high-risk gambles prevent normal respondents from choosing such gambles on subsequent trials. Busemeyer and Stout (2002), however, show that both cognitive and affective evaluation and learning processes are needed to account for the choices made by normal and abnormal populations with the Iowa gambling task.

Dynamic risk-taking tasks. Much real-world risk taking (e.g., binge drinking) involves repeated decisions where risk levels escalate as the result of previous decisions. Estimates of risk taking assessed in static risky-choice tasks do not predict risk taking in dynamic environments very well (Wallsten et al. 2005). Several assessment instruments have attempted to fill this gap. The initial tool was devised by Slovic in 1966 for use with children, who face the repeated choice between continuing in the game by pulling one of a finite number of switches that have a high (but decreasing) probability of earning a gain, or stopping to claim the accumulated rewards. One of the switches (the "devil") terminates the game, with a loss of all accumulated rewards. Performance in this game predicts real-world risk taking of children when crossing a street (Hoffrage et al. 2003).

The Columbia Card Task (Figner et al. 2008) is like the devil task in its nonstationary riskiness, as an increasing number of cards (out of 32) are turned over, but in addition, the task varies the number of loss cards that terminate the game as well as the gain and loss per gain and loss card. In addition, the task allows for net losses, not just the elimination of previous gains. Thus, the Columbia Card Task allows for an assessment of the sensitivity of respondents' choices across conditions (i.e., the quality of their information use) as well as their risk taking. In the Balloon Analogue Risk Task (Lejuez et al. 2002), points are gained with each puff that incrementally inflates a balloon, with an increasing probability that the balloon may burst and all acquired gains will be lost. Although it is structurally equivalent to the devil task and Columbia Card Task in that the risk of bursting increases with previous puffs, the Balloon Analogue Risk Task does not explicitly inform decision makers of this nonstationarity, and Wallsten et al. (2005) find that participants misconstrue the task as stationary. Pleskac (2008) focuses attention on the nonstationarity of risk in his Angling Risk Task by specifying either sampling with or without replacement (catch and release versus catch and keep) and by varying the clarity of the water and thus knowledge of remaining odds. Respondents are found to use cognitive strategies in contingent and adaptive ways in this domain of dynamic risk taking, just as reported for choice task 25 years ago (Payne et al. 1992) and for inference tasks more recently.

Intertemporal choice. Both cognitive and affective mechanisms have been demonstrated to give rise to the discounting of future events. The cognitive processes specified by QT, which also explain the endowment effect and the status quo bias, account for both individual differences in discounting and for the observed asymmetry in discounting when people accelerate or delay consumption (Weber et al. 2007). An affect- or impulse-based process for choices that allow for immediate consumption is assumed to give rise to hyperbolic discounting in Laibson's (1997) beta-delta model, with some neuroscience evidence corroborating the involvement of immediate affect (beta regions) in only such decisions, with other more cognitive (delta) regions being activated by all intertemporal tradeoff decisions (McClure et al. 2004) but also some dissenting opinions (Glimcher et al. 2007).

More impatience for choices involving immediate consumption is not always found when controlling for length of delay. Read (2001) alternatively explains hyperbolic discounting as a form of subadditivity of discounting: People are less patient (per time unit) over shorter intervals regardless of when they occur. Zauberman et al. (2008) find that people's subjective perceptions of prospective duration lengths are nonlinear and concave in objective time and that intertemporal choices reflect a relatively constant rate of discounting relative to subjective time.

Self-other discrepancies. A dual-process model also explains differences in the risky decisions people make for themselves versus those they predict others will make. Although one's own emotional reactions to choice options are very accessible and salient, those of others are not. Analytic considerations such as differences in expected value, on the other hand, can be assumed to apply equally to oneself as well as to others. As a result, people's choices on the gain (Hsee & Weber 1997) and loss side (Faro & Rottenstreich 2006) are further away from risk neutrality than are the predictions they make about the choices of others. Evidence that this discrepancy (and misprediction) is due to a different mix of affective and analytic considerations comes from the fact that the discrepancy is larger when predicting the decisions of abstract rather than concrete others (Hsee & Weber 1997) and is moderated by self-reported empathy (Faro & Rottenstreich 2006). Regardless of whether dual-process explanations will be supported by neuroscience evidence (see sidebar How Many Processes?), the distinction between affective and cognitive processes has been very fruitful at a conceptual level.

HOW MANY PROCESSES?

Dual-process models have enjoyed great success and popularity, perhaps in part because we seem to be drawn to dualities, both biologically (with two eyes, ears, arms, and legs) and philosophically (with point and counterpoint). Our review documents how dual-process models have accounted for many judgment and decision-making phenomena. A more global perspective suggests, however, that ultimately a single system needs to integrate input from two or more subsystems to move from deliberation to action. In contrast, a more local perspective suggests a need for more than two systems since, in addition to the distinction between a reflective and reflexive system, reflexive processes engage multiple mechanisms, including automatic emotional reactions, semantic priming, or automated action sequences (Evans 2008, Keysers et al. 2008). Going into the future, computational modeling of these different subsystems and their reciprocal interconnections will likely build on and possibly supersede dual-process arguments.

Dual-Representation Models

Knowledge representation is centrally connected to the psychological cognitive processes that make use of them. Fuzzy trace theory (Reyna 2004) accounts for apparent inconsistencies in inference and preference tasks by assuming that different cognitive processes can take advantage of different memory representations of choice options, i.e., encodings at different levels of precision, as a function of age and expertise (Reyna & Adam 2003). Dehaene et al. (2004) find evidence for an inbred rudimentary

number representation system, which presumably complements more sophisticated representations, in single-cell recordings that identify number-count cells in the monkey parietofrontal cortex.

Decision modes. Multiple-process assumptions underlie distinctions between qualitatively different modes of making decisions. Goals are chronic (personality-, gender-, and culture-based) and domain-specific, and they influence people's choice of affective, analytic, or rule-based processes because these decision modes differ in their effectiveness of satisfying material and nonmaterial goals (e.g., affiliation versus autonomy; Weber et al. 2005a). Social norms dictate the use of different decision principles in different domains (e.g., moral versus business decisions; Tetlock 2002). People seem to have metacognitive awareness that the mode in which a decision is made carries diagnostic information about the decision maker's motivation. Recipients of a requested favor evaluated the favor and favor granter differently depending on whether they thought that the favor granter had decided based on affect, cost-benefit calculation, or role-based obligation (Ames et al. 2004).

LEARNING

Homo sapiens needs to survive in stochastic and often nonstationary environments that require constant learning and updating. Although learning is often vicarious and transmitted to us in summarized form (similar to the prospectus of an investment option, providing a distribution of past returns), learning from experience still plays a powerful role in our judgments and decisions. Learning, as a topic of JDM research, may have been the proverbial baby that went out with the bathwater when the cognitive revolution replaced behaviorism. Most choice theories, including PT and DFT, do not include any learning processes (Pleskac 2008).

Elwin et al. (2007), in a historical summary of learning from feedback, go back to the argument made by Einhorn and Hogarth in 1978 that selective and incomplete feedback prevents us from accurate judgments and choices in many decision environments. Addressing the important and understudied topic of people's mental representation of feedback, they distinguish between positivist coding that represents what one sees and constructivist coding that represents what one believes, supplementing perception with knowledge and theory. They present evidence consistent with their constructivist representation that reinforces the view of attention as an active process.

Reinforcement-learning rules of the sort originally suggested by Bush and Mosteller in 1955 offer psychological process accounts for arriving at rational (Bayesian) learning as well as deviations. Reinforcement-learning rules have recently been investigated in a variety of JDM contexts. Fu & Anderson (2006) show that reinforcement learning provides an integrative explanation for a broad range of dependent measures in tasks from recurrent choice to complex skill acquisition.

Erev (1998) revisits signal detection theory and replaces its ideal observer cutoff with a cutoff reinforcement-learning process, allowing him to account for phenomena from conservatism to probability matching and the gambler's fallacy. Weber et al. (2004) show that reinforcement learning in risky decisions that are made from repeated personal experience predicts risk sensitivity to be proportional to the coefficient of variation of the risky options, rather than its variance, consistent with both animal and human data. Following March's 1996 simulations that demonstrate that reinforcement learning in risky choice in conjunction with adaptive sampling gives rise to PT's pattern of risk aversion for gains and risk seeking for losses, Denrell (2007) formalizes adaptive sampling in risky choice, i.e., option selection that utilizes the evaluations of choice options that are constantly being updated in the ongoing decision-by-experience process. The model predicts that apparent risk taking and risk avoidance can be the result of adaptive

sampling, even when the decision maker has a risk-neutral value function and learning is optimal, reinforcing the realization that the relationship between risk attitudes and observed risk taking is more complex than envisaged by expected utility (Weber & Johnson 2008). Denrell's (2007) model also predicts that information about foregone payoffs will affect risk taking, consistent with other attempts to incorporate counterfactual outcomes or fictitious play into reinforcement-learning models (Camerer & Ho 1998). Finally, Erev & Barron (2005) operationalize implicit decision-mode selection as a reinforcement-learning process, where past success with different modes dictates their future use. They show that, in repeated risky decisions from experience, their model accounts for the observed effect of payoff variability, the underweighting of rare events, and loss aversion.

Practice ought to make perfect, and researchers have continued to look for evidence of optimal performance. Recently, such performance has been reported for human movement-planning tasks, where the tip of a finger needs to be placed on a computer touch screen so that gains will be incurred for hitting indicated target areas and losses are avoided for indicated penalty areas (Trommershauser et al. 2006). People learn to execute such pointing responses in ways that resemble expected-value maximization and are very accurate in selecting the higher expected-value option from a pair of possible responses. These tasks can be shown to be conceptually equivalent to choices between money gambles, where people often fail to achieve expected value or expected utility maximization (Erev & Barron 2005). More research on the precise differences between this paradigm and gambling choices is needed, but some differences are apparent. There is clear goal focus in the pointing task (hitting target area and avoiding penalty area), the appearance of a correct answer that can be found rather than a preference to be expressed, a continuous space of response alternatives, and a large amount of feedback.

Predictive Accuracy

Future states/experiences. Most decisions are forecasts of how options will make us feel in the future. This idea is captured by the distinction between decision utility (how we think options will make us feel) and experience utility (how experiencing those options actually feels). People tend to underestimate the ease of adapting to lifetime changes such as a move from California to Ohio, winning the lottery, or being turned down for tenure (Kahneman 2000). Other systematic mispredictions of subsequent experiences have recently been reported for regret (Sevdalis & Harvey 2007), loss (Kermer et al. 2006), and time slack and time savings (Zauberman & Lynch 2005).

Expected utility: the average utility from some risky choice. Like expected value, except that outcomes are nonlinearly transformed into utilities, usually with decreasing marginal returns

Two mispredictions of time provide cognitive-process explanations for intertemporal inconsistencies (in contrast to the affective or dual-process explanation discussed above). Zauberman & Lynch (2005) show that time-money tradeoffs change over time because people have more (and overly) optimistic predictions about future time availability than about money availability. Greater discounting of costs in time than costs in money can lead to housing/commuting time decisions that do not maximize experienced well being. Trope & Liberman (2003) show that we often mispredict our preference among choice options that lie in the future because we construe events that lie in the future in more abstract and higher-level terms than events in the near future or present.

Anticipation of negative emotional reactions such as regret or negative reactions to loss after outcome feedback is received helps to motivate careful analysis of choice options and their possible outcomes (Connolly & Zeelenberg 2002). It is also adaptive to have mechanisms in place that minimize these negative feelings, ex-post, as they decrease outcome satisfaction and consume processing capacity. The fact that people experience fewer negative emotions as they get older (Mather & Carstensen 2003) suggests that negative emotion regulation is an acquired skill.

Events. Predicting future events is a challenging task, as documented by Tetlock (2005) in a longitudinal study of expert political predictions. The accuracy of predictions of future key political events is generally not much better than chance. However, experts who acquire information broadly and on multiple topics, and who contingently apply different prediction strategies (foxes, in Isaiah Berlin's terms), are more successful in predicting future events than are experts who specialize in a small field and apply a smaller number of strategies more rigidly (hedgehogs).

CHARACTERISTICS OF THE DECISION MAKER

JDM research in psychology and economics has been mostly interested in average or typical behavior. Exceptions to this are risky and intertemporal choice, where individual differences in behavior have been examined and incorporated into normative models as parameters that capture the individuals' taste for risk and time delay. Risk attitude in particular (ranging from risk aversion to risk seeking) has sometimes been treated as a trait, despite a long literature showing that risk attitudes as measured by expected utility lack the cross-situational consistency required of traits. Personality theory's insight that individual traits exist but interact with situational variables explains existing results about the domain specificity of risk taking without giving up on stable traits (see Weber & Johnson 2008). Recent statistical advances such as hierarchical linear modeling and related Bayesian methods provide means to measure and explain individual differences in behavior in these more sophisticated ways.

Research over the past decade suggests that individual and cultural differences in decision making seem to be mediated by two classes of variables: (*a*) chronic differences in values and goals, presumably related to historical, geographic, or biological determinants, that focus attention on different features of the task environment and its opportunities and constraints; and (*b*) differences in reliance on different automatic versus controlled processes, related to cognitive capacity, education, or experience. The review below is organized by predictor variable ("what individual difference dimension?"), describing for each which dependent measures ("what behavior?") this individual difference moderates. Dependent measures for which individual differences have been reported include (*a*) observed judgments or choices, in particular reported perceptions of risk, and risky and intertemporal choices; (*b*) model-based parameters inferred from observed behavior, including risk aversion and loss aversion; (*c*) the accuracy of judgments or inferences, as measured by their adherence to true values; and (*d*) the consistency of judgments or choices across situations/frames. In some instances, what we list as predictor variables are themselves shown to be predicted by other predictor variables.

Gender

Women appear to be more risk averse in many contexts and situations (Byrnes et al. 1999, Jianakopolos & Bernasek 1998). When the sources of this observed gender difference in risk taking are unpacked, women perceive the riskiness of choice options to be larger in most domains (all but social risk; see Weber et al. 2002) rather than having a more averse attitude toward risk as they perceive it. In those (and only those) domains where they perceive the risks to be larger, they appear to be more risk averse. Slovic (1999) summarizes evidence that observed gender differences in risk taking are not essentialist (i.e., biological), but rather the result of deep-seated affective comfort (or discomfort) with risk (feeling that it is controllable, or not) that comes with lower social status in a society. Emotional discomfort translates into larger perceptions of riskiness, an affective mechanism that connects these individual differences in risk taking to situational effects such as the home bias in investment decisions (Weber et al. 2005b) or gain/loss framing in medical informed-consent communications (Schwartz & Hasnain 2002). In contrast

to these reliable gender differences in risk taking, no consistent gender differences have been reported on loss aversion or time discounting.

Age

Because psychological processes have developmental trajectories, JDM research has shown interest in comparing the decision processes and competencies of children, adolescents, younger, and older adults. Web-based experiments and field data have contributed to this interest with JDM data from a wider range of ages. Space limitations restrict us to a small subset of relevant studies and a focus on younger versus older adults. Gaechter et al. (2007) show that loss aversion measured in both risky choice and riskless consumer choice increases with age, with no significant gender effect. Older adults have also been found to be more risk averse (Jianakopolos & Bernasek 2006), though not every study finds this effect. Evidence on age effects on time discounting is also more mixed, with some studies showing no effect and others showing that both older and younger adults discount more than do middle-aged adults (Read & Read 2004). Age also affects what information is encoded and utilized. Consistent with evidence on life-span changes in emotion regulation, Carstensen & Mikels (2005) show greater effects of negative mood on the decisions of younger adults and greater effects of positive mood on the decisions of older adults.

Personality

Based on factor analyses in the 1960s and 1980s, personality theory has focused on five traits in recent years. Some JDM research has examined whether people's scores on the "big five" dimensions affects their decisions. Risk taking has again been the most common dependent measure examined. Thus, Nicholson et al. (2005) find that risk takers score high on extraversion and openness and low on neuroticism, agreeableness, and conscientiousness. Nicholson et al. (2005), as well as Zuckerman & Kuhlman (2000) and Weber et al. (2002), also identify sensation seeking as associated with risk taking. Levin et al. (2002) examined the effects of personality traits on susceptibility to framing. Attribute-framing effects (e.g., meat 90% lean versus 10% fat) were larger for individuals low in conscientiousness and high in agreeableness. Risky framing effects (e.g., lives lost versus lives gained) were larger for individuals high in conscientiousness and neuroticism.

Cognitive Traits/Styles

Cognitive reflection test. The cognitive reflection test (CRT) is a three-item math-puzzle test designed to elicit an incorrect "intuitive" answer (generated by System 1) that needs to be overridden by System 2 intervention (Frederick 2005). Individual differences in people's ability to do so are found to be correlated with greater patience (less discounting) in intertemporal choices as well as risky choices closer to expected value maximization (less risk aversion for gains, less risk seeking for losses). This suggests that normative choice models may turn out to be descriptive for at least a subset of the general population, those who have a greater ability or inclination to use rational/analytic processing in their decisions. CRT scores correlate moderately with conventional IQ measures, some of which show higher correlations than the CRT with normative choices in specific domains. However, the CRT is the most consistent predictor across choice measures and by far the easiest test to administer.

Numeracy. Numeracy, defined as the ability to process basic mathematical and probabilistic concepts and measured by a scale created by Lipkus and colleagues in 2001, is uncorrelated with general IQ measures but has been shown to be reduce susceptibility to framing effects and improved judgment accuracy (Peters et al. 2006b). Somewhat counterintuitively, more-numerate individuals perform more accurately because they derive stronger and more accurate affective meaning from numbers and their comparisons.

Maximizing/satisficing/regret. Simon's 1957 distinction between maximization and satisficing as a choice objective has also been turned into an individual difference measure (Schwartz et al. 2002). Scoring higher on the maximization part of the scale has been found to be a net negative. Thus, maximizers find higher-paying jobs but are less satisfied with their job choice and experience, presumably because they are more susceptible to regret (Iyengar et al. 2006). de Bruin et al. (2007) also find the propensity to regret and tendency to maximize to be negatively related to the reported quality of decision outcomes and to decision-making competency, described next.

Decision-making competency. Fischhoff and colleagues have attempted to capture a common skill component in the judgments and choices made by adolescents (Parker & Fischhoff 2005) and adults (de Bruin et al. 2007). Combining performance on seven JDM tasks that can be scored for either accuracy or consistency into a decision-making competency measure, they find that this score is positively correlated with the reported quality of decision outcomes, even when controlling for IQ, age, and socioeconomic status. Older respondents showed greater competency in some of the seven tasks (recognition of social norms and resistance to sunk costs) but did worse on other tasks (applying decision rules and framing effects) (de Bruin et al. 2007), suggesting that there is more than a single underlying competency factor.

INCREASING POLICY RELEVANCE

One of the appeals of behavioral decision research has been that the questions that are at the forefront of the research agenda are also, at times, at the forefront of social concerns. Recently, we have seen an explosion of research that applies principles from behavioral decision research to address applications in policy and other areas (Thaler & Sunstein 2008). As we have argued, this increased translation from laboratory research on judgment and choice to the policy arena is facilitated by the increasing psychological process orientation of the field. Space constraints force us to be selective, focusing on health and wealth, and covering only a small subset of applications of JDM insights within those domains.

Health

Obesity is the result of thousands of small choices that have the outcome that caloric intake exceeds the decision maker's caloric expenditure. Wansink (2006) argues that these choices are often made with little awareness and shows in a series of clever experiments that making consumption decisions more mindful can change people's eating behavior. More importantly, changes in the decision environment that are cognizant of the simplifying evaluation and choice processes people apply (e.g., serving potato chips in small, single portions rather than a large bowl, because we evaluate consumption relative to bowl size) have the effect of reducing consumption.

Another important social issue addressed by JDM research has been the shortage of organs relative to demand for life-saving transplants. Johnson & Goldstein (2003) noticed that different European countries have different defaults for citizens who did not make an active decision concerning their status as an organ donor. They built upon prior work examining the effect of defaults and demonstrated—with a Web-based survey and archival records of organ-donation signups—that significantly more people are willing to be donors when the default is to be a donor (with the need to opt out in order not to be a donor) than when an active choice must be made to be a donor. They also demonstrated that the actual rate of organ transplants is significantly larger in opt-out than in opt-in countries (see also Gimbel et al. 2003). The observed effects are large, suggesting that the current shortage of some organs,

such as hearts, could be overcome by a change in defaults.

Wealth

Similar to organ donation, participation rates in retirement savings plans are at levels judged too low. In the United States in particular, many employees are not saving toward their retirement even when their employers provide substantial financial incentives in the form of matching contributions. When Madrian & Shea (2001) changed the default action that was implemented when employees did not make an active decision to participate in a 401k plan from the usual one of no savings contribution to one of 3% of income contribution, participation of employees in the plan increased from 37% to 86%. Inspired by this and similar studies, the Department of Labor, with the help of enabling legislation, has allowed employers to change defaults. Thaler & Benartzi (2004) address the same problem with an intervention inspired by multiple behavioral-research insights. Their save-more-tomorrow plan capitalizes on discounting by asking people to commit to saving in the future, and it minimizes the impact of loss aversion by taking the contributions out of future raises rather than current income, as well as by making contributing the default. Initial applications have shown widespread adoption (by 78% of those who are offered participation, with 80% of them remaining in the program through four pay raises), and savings rates have increased from 3.5% to 13.6% of income. Retirement savings is one clear example of where behavioral decision research is having significant personal, business, and public policy effects.

Implications: The Behavioral Advantage

In each of these applications of JDM theory, the interventions suggested stand in contrast to interventions that might be suggested by standard economics. In the case of retirement savings, standard economic analysis suggests rather expensive government interventions (such as tax incentives) or effortful (for both provider and recipient) public education. The use of defaults is not only more effective but also much less costly. The same observation applies to organ donation, where the solutions suggested by economists (markets of some sort or other financial incentives) rightfully generate a lot of public controversy. Redesigns of the decision environment in ways described in our examples provide the same amount of choice flexibility and autonomy to the decision maker as do existing environments, but redirect, in a psychological jiu-jitsu, potentially harmful decision aversion to individually or socially desirable outcomes. Redesign of decision environments also follows directly from the psychological idea of constructed preferences, affects, and inferences.

CONCLUSIONS

Historically, JDM research has taken normative economic and statistical models as its starting point and adjusted them, one small step at a time, to keep the benefits of those models while giving them greater predictive accuracy. This incremental approach resulted in a proliferation of task-specific models that provide better predictions of observed behavior than do normative models, perhaps at the price of parsimony and impact on other social science disciplines. However, our review suggests that the small incremental adjustments to economic models, in their accumulation over the past 50 years, have added up to and converge on a more psychological theory of JDM. In addition to being integrative by reducing a large number of models and insights to a manageable list of underlying perceptual, cognitive, and emotional considerations, a psychological process framework also provides entry points for a better and possibly causal understanding of JDM phenomena and thus for intervention.

A recent review of our understanding of heuristics by Shah & Oppenheimer (2008)

makes a very similar point. Arguing persuasively that the word "heuristic" has been used so indiscriminately as to have lost its meaning, the authors show that defining heuristics within an effort-reduction framework that is based in cognitive information processes reduces conceptual redundancy and allows domain-general principles to emerge. The integration and grounding of JDM theories and phenomena into psychological processes has been happening more at the cognitive end of psychology. It is also important to connect JDM research more firmly to theories and data about human motivation and emotion provided by other areas of psychology. Heath and colleagues (1999), for example, interpret goals as reference points, arguing that goals are motivating because of basic cognitive and perceptual processes, and thus illuminate the motivational properties of PT's value function. A focus on goals may provide a natural way of further integrating social and cognitive psychological insights. Goals play a central role in self-regulation (Higgins 2005) and have been shown to influence the way decisions are made, with the decision process in turn affecting the decision outcome (Weber et al. 2005a). Cognitive investigations of judgment and choice will benefit from addressing the focusing role of desires and goals. The impact of work in social cognition on behavioral decision research will be greatly enhanced by considering the cognitive processes that mediate reported behavior; we would encourage investigations that emphasize what the field knows about finite attention and implicit memory, a strategy that we believe contrasts with a focus on unconscious processing (Dijksterhuis 2004).

The debates of previous decades about rationality have abated, giving way to the realization that a given behavior is "rational" or not only within a specific definition of rationality and that there are several standards, each having merits within a (different) set of goals and constraints (Reyna et al. 2003, Tetlock & Mellers 2002). Emerging instead is a realization that broad-scale characterizations of human judgment or choice as flawed or rational are not particularly useful. The data often speak with greater clarity and less dissent than polarized characterizations of them that are designed to buttress ideological positions. Consider, for example, the 1978 Lichtenstein, Fischhoff and Slovic study of estimates of perceived lethality and the 1996 Gigerenzer and Goldstein study of heuristics used in identifying the relative size of cities. The first study is cited as evidence that people are often biased in their heuristic judgments, the second as a demonstration of how good heuristic performance can be. In fact, judgment accuracy is very similar for both tasks, with mean correlations between estimated and actual lethality of around 0.7 and between estimated and actual city sizes of around 0.6. The types of errors made are also very similar in both data sets. People overestimate the frequencies of homicide relative to suicide, a result attributed to greater availability due to media biases in reporting. And German respondents choose Dallas as the larger city too often, relative to San Antonio, presumably due to greater availability as the result of the eponymous television show popular in Germany. A focus on understanding the causes of observed effects may be more productive than interpretations of data along ideological lines. Controversies of this sort are only partially addressed and resolved by adversarial collaborations (e.g., Mellers et al. 2001), which tend to focus on boundary conditions and relative effects sizes rather than the existence of shared or distinct mechanisms for the phenomenon under study.

The view of *Homo sapiens* as an adaptive decision maker has continued to receive support. Although we are restricted by finite attentional and processing capacity, we also are blessed by an abundance of ways in which we can focus and utilize this finite capacity that extends from goals to processes. We apply a wide repertoire of processing modes and strategies to our choices and inferences in a fashion that is cognizant of our goals, capacities, and internal and external constraints. In addition to strategies that differ in effort and accuracy (compensatory algorithms versus noncompensatory heuristic shortcuts), the past 10 years of research have

also considered the information (material versus nonmaterial considerations) and processes (automatic versus controlled) used by different decision strategies. Whether identified decision strategies fall into two classes (Kahneman 2003) or along a continuum (Hammond 1996, Svenson 2003), some decision strategies are more automatic, associative, and affect laden, whereas others involve either implicit or explicit attempts to consider the pros and cons of different choice alternatives. Recent JDM research has also examined a broader set of goals/criteria assumed to underlie decision makers' implicit strategy selection, no longer restricted to effort and accuracy, but also including self-concept and self-regulation, social goals, and internal and external needs for justification. Content- and context-primed attention to subsets of goals (Krantz & Kunreuther 2007) and context- and path-dependent encoding, evaluation, and memory-retrieval processes have been shown to help us to come up with a satisfactory choice option in a short amount of time and without too much postdecisional regret. Predecisional distortions in the form of information-search or argument-generation processes that bias the balance of evidence in adaptive ways help us do so.

Functional-relationship explanations of deviations of behavior from normative models (e.g., PT for risky choice, hyperbolic discounting for intertemporal choice) can be further unpacked into psychological process explanations for observed regularities. Even though PT and hyperbolic discount models do not claim to be anything other than "as-if" models, people often take them as literal, interpreting both loss aversion and hyperbolic discounting as emotion-mediated effects. Our review has shown that, although affective processes play a role in both cases, cognitive (perceptual, attention, and memory) processes account for a large proportion of the variance in behavior (Johnson et al. 2007, Weber et al. 2007, Zauberman et al. 2008). A better understanding of the determinants of attention as a function of task, context, and characteristics of the decision maker is clearly a promising direction for future research (Payne et al. 2004).

To the extent that Annual Review articles provide a "state of the union" evaluation of a field, we declare that the JDM field, as it is entering early adulthood, is alive and well. It is a vibrant research enterprise, which young researchers are joining in record numbers; graduate student enrollment in the Society for Judgment and Decision Making grew by more than 40% over the past five years. It is also a global enterprise, with active research programs worldwide. Policy makers and institution builders in the private and public sector are applying its insights. The media report on its research, and popular books on the subject become bestsellers. With success comes responsibility. We encourage researchers to build on the successes and advances covered in this review, which means emphasizing common insights, processes, and results just as much as highlighting differences between models.

Incremental modifications of normative economic models have given shape to a psychological theory of JDM. This current theory shows the importance of understanding how decision makers attend to provided information, seek out additional information both by internal (memory) and external search, how information gets evaluated and integrated by both cognitive and affective processes, and how all of these stages are influenced by the decision environment (task, content, context) and the decision maker's internal state (beliefs, values, goals, prior experience). There is no question that this view of JDM is complex and not easy to translate into mathematically or otherwise tractable models. However, recent appeals to keep economics "mindless" (Gul & Pesendorfer 2005) to maintain the simplicity and coherence of its theoretical framework strike us as a self-imposed sentence of intellectual solipsism and policy irrelevance. The existing successes of a constructivist JDM research agenda that uses what we know about the mind of the decision maker to predict or modify consequential judgments and decisions hold future promises that clearly outweigh the drawbacks of its complexity.

SUMMARY POINTS

1. Psychological process explanations have helped integrate JDM phenomena and provide prescriptions for how to improve decision quality.
2. The emotions revolution has put affective processes on an equal footing with cognitive processes.
3. Selective attention and information recruitment and retrieval processes explain the effects of task, context, or prior history.
4. Internal or external evidence generation in constructed preference is path dependent.
5. Dynamic risk taking differs from static risk taking, and decisions from experience differ from decisions from description.

FUTURE ISSUES

1. Goals versus utilities as the fundamental primitive of decision research.
2. Translation of attention into decision weights.
3. Origin and updating of reference points and the dynamics of multiple reference points.
4. Further understanding of individual, group, and life-span differences in performance on JDM tasks.
5. Translation of JDM results to inform and improve public policy.

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The authors are not aware of any biases that might be perceived as affecting the objectivity of this review.

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