Individual Judgment and Decision Making Processes: Influences on Public Participation in Environmental Assessment and Decision-Making

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Introduction

Effective and meaningful public participation in environmental decision-making is advocated as a means to reduce social conflict, increase the acceptability of choices, and improve the efficiency and quality of regulatory decisions (e.g., Rowe & Frewer, 2004; Stern & Fineberg, 1996**)**. Recent national discussions regarding environmental management in society have underscored the need to integrate and accommodate both traditional scientific paradigms and public perspectives (e.g., EPA, 2003; Stern & Fineberg, 1996; President's Commission on Risk Assessment and Risk Management, 1996). Ideally, public participation achieves desirable goals by decreasing distrust among involved and affected parties, legitimizing public concerns, empowering stakeholders, increasing the political feasibility of technical decisions, improving the science used to assess risk or evaluate options, and supporting democratic values (Rowe & Frewer, 2000; Futrell, 2003).

Despite the desirability of participatory strategies for environmental decision- making, attempts to engage in more collaborative and inclusive processes can result in unanticipated difficulties (Petts, 2004). Clearly, one significant challenge for early community involvement is defining a larger role for the public given that many relevant tasks have been viewed as strictly in the realm of experts, or "science-based" activities. Some policy makers believe that a more inclusive decision strategy might compromise the scientific integrity of quantitative or formal estimation of risks and benefits (Brooks & Johnson, 1991; Gostin, 2000; Graham, 2000; Perhac, 1998; Pollak, 1996; Rowe & Frewer, 2000), even though some evidence suggests broader participation can result in better technical representations of environmental or risk problems and decision options (e.g., Futrell, 2003). There is broad agreement that environmental assessments and decisions must be informed by, and reflect, sound scientific principles and products (e.g., Futrell, 2003; Koontz & Johnson, 2004; Stern & Fineberg, 1996). Therefore, consideration of complex information, or at least deciding about the trustworthiness of technical evidence, may be a frequent judgment activity for non-science groups during a participatory process.

Efforts to expand the public's role in environmental decision-making also have encountered other difficulties. Paradoxically, implementation of participatory strategies can increase rather than decrease social conflict and public discontent, and the quality of ensuing decisions can greatly vary (e.g., Koontz & Johnson, 2004). In some cases, this may be due to well-intentioned, but somewhat misguided decision and communication strategies. In the past, some approaches have failed to reflect scientific knowledge from the psychological sciences about individual-level judgment and decision-making processes. Psychosocial determinants of judgments and decisions affect the quality and characteristics of public participation in analytic-deliberative problem solving. Relevant processes include motivations, consideration of

probabilities and other aspects of complex decision problems, values, emotions, levels of trust in involved parties, risk perceptions, reasoning strategies, framing of problems and interpretations of events (e.g., McComas, 2003; Trumbo, 1999).

Striving for technically sound and socially acceptable environmental policies through "hybrid" decision models that integrate analysis and deliberation implicitly assumes certain "truths" about human judgment and decision-making. This is especially the case for those participatory strategies that involve a broad range of stakeholders or are applied in high conflict situations (Koontz & Johnson, 2004). One assumption is that the public's preferences, priorities, interests and perspectives in a given situation are stable and knowable (e.g., Chase, Decker & Lauber, 2004; Petts, 2004). Second, although final decisions will result from factors other than traditional scientific analyses and assessments, public consideration of scientific evidence and technical information is relevant to, and productive for, the deliberative process (e.g., Chase et al., 2004). Third, individual-level capabilities and strategies for information processing, reasoning and decision-making are consistent with a process of collaboration (e.g., Bond et al., 2004; Futrell, 2003). Fourth, even though initial differences may exist among involved parties, agreement can be reached about how to frame the problem, what data are relevant for decision-making, how technical information is considered and what criteria are used to evaluate the desirability of decision options (Futrell, 2003; Petts, 2004). Thus, flexibility in initial judgments, evaluations and expectations is assumed.

How tenable are these underlying assumptions, and under what circumstances or in which contexts might they be valid? The body of evidence on the psychology of judgment and decision-making at the individual and small group levels provides considerable insights on these questions (See chapter by Paul Stern for a discussion of small group processes in decision making and conflict resolution). Although many general discussions of participatory strategies refer to the "public," "stakeholders" or "a community" as one group among several involved in the decision process, in any given situation, it is specific individuals and identifiable small groups who collaborate, consider options and make judgments and decisions (Koontz & Johnson, 2004). Thus, the psychological processes that influence individuals' reasoning, risk perceptions, evaluation of outcomes or statistical information, assessments of other involved parties, integration of information and capacity to consider complex evidence are critical contributors to the success or failure of collaborative or participatory approaches (Bond et al., 2004).

This paper presents a focused summary of results and theories from substantial literatures in the psychology of judgment under uncertainty, behavioral decision-making, uncertainty management, negotiation and risk perceptions. This review is selective in that we highlight those research findings and theories that are most directly relevant to analytic-deliberative decision-making. Several recent reviews of empirical studies on human judgment and decision (e.g., Gilovich, Griffin, & Kahneman, 2002; Hastie & Dawes, 2001; Kahneman, Slovic, & Tversky, 1982; Mellers, Schwartz, & Cooke, 1998; Shafir & LeBoeuf, 2002) present excellent general discussions of empirical work in these areas and the "basics" were covered very well in *Understanding Risk*. The present summary considers several processes that influence how stakeholders arrive at a specific judgment or decision when participating in environmental assessment and decision-making. Some of the most useful topics from the psychological literature include: ways of representing, reasoning about and processing information in a conflict situation (Carnevale & Pruitt, 1992); linkages between emotion or affect and reasoning about risk (Loewenstein, Weber, Hsee & Welch, 2001; Peters & Slovic, 1996); judgment predispositions due to the framing of decision problems, conflict or outcomes (Bar-Tal, 2002;

Bazerman, Curhan, Moore & Valley, 2000; Brandenburg & Nalebuff, 1996; Gilovich, Griffin & Kahneman, 2002); mental models in negotiation (e.g., Bazerman et al., 2000; Thompson & Hastie, 1990); cultural influences on reasoning and judgment during disputes (e.g., Kamenstein, 1996; Triandis, 2000); valuation of options or outcomes (e.g., Gilovich & Griffin, 2002); and the impact of uncertainty on the salience of particular values such as fairness and justice (e.g., Van den Bos & Lind, 2002).

In addition to summarizing theories and empirical data on individual judgment and decision-making, in a subsequent section we suggest some possible strategies to improve analytic-deliberative processes from the perspective of the individual decision maker. Although this summary emphasizes judgments, decision-making and risk perceptions at the level of the individual, we recognize that other social and organizational processes undoubtedly influence public judgments when communities collaborate with experts and representatives of regulatory agencies or industry in environmental decision-making.

Reasoning about Complex Environmental or Risk Problems

Overview of Dual-Process Models of Reasoning and Information Processing

During an analytic-deliberative process, individuals are likely to vary in how extensively relevant information is considered and the effort put forth to deliberate about a problem. Regardless of the quality and quantity of technical or other information provided by regulatory agencies or experts, some involved and interested parties will deliberate extensively, whereas others will weigh information only minimally in forming a judgment; some will ignore available information altogether (Lindbladh & Lyttkens, 2003; Trumbo, 1999). At an early stage of the judgment process, strategies for information processing and reasoning are adopted and a determination made about the level of cognitive resources that will be committed to the task at hand (Miller et al., 1996). Individuals display considerable flexibility in how evidence or information is used to reason about an event (e.g., Hammond, 1996), and judgments may be arrived at through two different, but interacting and interdependent routes (Chaiken, 1980; Kunda, 1990; Petty & Cacioppo, 1986; Miller et al., 1996; Witte, 1994). Cognitive resources may be conserved through the use of heuristic, intuitive or experiential approaches that apply simpler decision rules (designated as System 1 by Stanovich & West, 2000), or in contrast, significant cognitive effort may be exerted to scrutinize and deliberate about facts through an analytic or effortful strategy [System 2] (Stanovich & West, 2000). A variety of theorists have proposed and generated empirical evidence supporting two-process theories of reasoning, and have speculated about the properties and implications of these two systems (e.g., Bohner, Frank, Renhard, Einwiller & Erb, 1998; Chen, Duckworth & Chaiken, 1999; Epstein, Pacini, Denes-Raj & Heier, 1996; Hammond, 1996; Kruglanski & Webster, 1996; Reyna, 2004; Trumbo, 1999; Trumbo & McComas, 2003). Importantly, judgments derived from System 1 feel intuitively correct, are more affect or emotion-based and tend to support prior beliefs (Epstein et al., 1996; Klacyznski & Robinson, 2003). Judgments grounded in System 2 reasoning are more rule-based, and result from more traditional notions of scientific or analytical reasoning. Evidence may be probed extensively for flaws and strengths, and the justifications for data rejection require more sophisticated arguments (Klacyznski & Robinson, 2003).

Individuals who differ in the predominant system of reasoning used to evaluate and structure a decision problem will likely differ in needs and requirements to arrive at judgments during analytic-deliberative problem solving. Moreover, differential usage of Systems 1 and 2

may lead to differences in: the representation of risk and decision problems (Reyna, 2004; Stanovich & West, 2000), tendencies to dismiss evidence based on scientific principles (Klacyznski & Robinson, 2003), and the effectiveness of specific communication approaches (e.g., Epstein et al., 1996). Each system is associated with its own set of advantages, limitations and biases in reasoning and decision-making (Epstein et al., 1999; Kahneman, 2003; Stanovich & West, 2000). We discuss these more specifically in subsequent sections of this paper and consider implications for risk perceptions, consideration of complex evidence and conflict resolution.

Motivations and Reasoning. There are several factors that may lead members of the public to engage in one system of reasoning as opposed to another. For example, in risk situations, high credibility of government agencies or industry tends to promote heuristic vs. analytical processing in public groups, and this may lead to lower risk perceptions regarding an environmental exposure (e.g., Trumbo & McComas, 2003). However, some of the most significant contributors to mode of reasoning are motivational factors. Interactions between motivational and cognitive processes in judgment and decision-making provide an explanation for why information encoding, processing and reasoning can differ substantially among individuals or across contexts (e.g., Chaiken, 1980; Witte, 1994; Petty & Cacioppo, 1986). Motivation levels determine the type and extent of information processing, and reflect the immediate goals of the decision-maker (e.g., Chen et al., 1999, Kunda, 1990; Trumbo, 1999; 2003). In any particular judgment situation, motivation to deliberate can be affected by stable person characteristics such as cognitive ability, preferred information processing style or uncertainty orientation (e.g., Edwards, 2002; Sorrentino & Short, 1986; Thompson et al., 1994; Trumbo & McComas, 2003), as well as more transient features of the immediate decision context such as task importance (e.g., Bohner et al., 1998; Chen et al., 1999; Kunda, 1990; McElroy & Seta, 2003; Petty & Cacioppo, 1986). Motivated processing and reasoning may reflect accuracy, defense or impression motivation (Chen et al., 2000).

Dual-process models of reasoning propose that information-processing route is dependent on motivation-cognition structures. Factors capable of modifying motivation to engage in effortful decision-making may indirectly influence the mode and depth of processing (e.g., Chen et al., 2000; Stanovich & West, 2000). Indeed, certain negative cognitions such as low self-efficacy, perceptions of vulnerability, low perceived control and pessimism lessen the motivation to engage in more analytic reasoning (e.g., Bohner et al., 1998; Rogers & Prentice-Dunn, 1997; Taylor & Seeman, 1999; Trumbo, 2002; Witte, 1994). These orientations have been documented in some affected populations dealing with a chronic environmental or risk problem (e.g., Adeola, 2000; Bohm & Pfister, 2000; Kroll-Smith & Couch, 1991). If activated, these beliefs diminish a positive expectancy that information processing or effortful reasoning will actually help achieve goals and that the individual is capable of successfully carrying out the activity (e.g., Bohner et al., 1998; Trumbo, 1999). Expectancies about processing efficacy, the likely outcome of reasoning activities and the value of reasoning for goal achievement may be crucial components of the motivation to engage in effortful reasoning (e.g., Bohner et al., 1998). The dual-process model of reasoning provides a useful framework by which to understand the impact (or lack thereof) of evidence and other information on stakeholders' judgments and decisions during an analytic-deliberative process. Motivated reasoning and its relationship with other judgment and decision processes are further explored in subsequent sections of this paper.

More about Defensive or Impression Motivations and Reasoning. Motivation to reach particular conclusions or to achieve other outcomes (e.g., avoiding regret, protecting one's self-

image) often plays an important role in judgment and decision-making (for reviews, see Chen et al., 2000; Kunda, 1990; Larrick, 1993). People frequently restructure problems to avoid or conceal difficult tradeoffs and to construct apparently dominant alternatives (Montgomery, 1983; Svenson, 1992, 1996). For example, people may combine attributes of alternatives into larger groups to avoid the appearance of tradeoffs, or change the relative importance of attributes. In addition, people's initially preferred alternatives may bias their interpretation of additional information about consumer products (Russo, Medvec, & Meloy, 1996, Russo, Meloy, & Medvec, 1998; Russo, Meloy, & Wilks, 2000) or about probabilities and outcomes in risky decisions (DeKay et al., 2003). Finally, people may have biased, self-serving interpretations of fairness in negotiation settings (Babcock et al., 1995; Loewenstein et al., 1993).

Reasoning about Uncertainties

Uncertainty management. Reasoning about and evaluating uncertainty have significant consequences for an individual's judgments about a policy issue (e.g., van den Bos, 2001). In general, uncertainty is threatening, and needs to be eliminated, made tolerable or managed (van den Bos & Lind, 2002). In an environmental assessment and decision situation, uncertainty can be temporary or ongoing, and represented in formal models or informally assessed. If prolonged, it may become the primary catalyst for undesirable responses such as an extended search for symptoms or signs of illness linked to environmental exposures (e.g., Adeola, 2000; Edelstein, 1988; Gatchel & Newberry; 1991; President's Commission on Three Mile Island, 1979). In addition, uncertainty can trigger the onset of chronic stress (Vyner, 1988). These high levels of stress can then influence how individuals reach decisions about a risk situation and interpret risk communications (e.g., Covello et al., 2001; DiGiovanni, 1999; Finucane et al., 2000).

The paradigm of uncertainty management (e.g., Bradac, 2001; Brashers, 2001; Goldsmith, 2001) is particularly useful for examining the dynamics of participatory processes when the quality, content and communication of scientific evidence, and the characterization of uncertainty, are crucial aspects of interactions between risk managers and affected populations. Trust and procedural fairness considerations become highlighted in the context of perceived uncertainty (van den Bos & Lind, 2002), and under these circumstances, individuals may be more vigilant, displaying a heightened interested in evaluating the credibility of information sources (Brashers, 2001; van den Bos, 2001; Halfacre et al., 2000). When uncertain, individuals tend to become more rigid about beliefs and policy preferences, and may display reasoning and decision strategies that are characterized by a narrowing of attention, less systematic scanning of information and premature ending of the search for facts (e.g., Covello et al., 2001; Janis & Mann, 1977; Klein, 1996). If uncertainty is perceived to be significant, individuals are more likely to challenge the reliability and adequacy of derived quantitative estimates, remain reluctant to accept reassurances about the relationship between health outcomes and exposures (Kroll-Smith & Couch, 1995; Rich, Edelstein, et al., 1995) and may conclude that the primary concerns of the community are unaddressed by formal risk analysis (e.g., Brown, 1990; Gusterson, 2000; NRC, 1996; Thompson & Gonzalez, 1997). Information uncertainty is sufficient, in itself, to make people emphasize fairness, and under these circumstances, judgments of procedural fairness become particularly important to the decision-making process (See, 2000; van den Bos. 2001; van den Bos & Lind, 2002).

Probabilistic reasoning. The heuristics-and-biases literature is replete with demonstrations that people violate the rules of probability theory (e.g., *conjunction errors*, *base-rate neglect*) (Kahneman, Slovic, & Tversky, 1982; Gilovich, Griffin, & Kahneman, 2002). Gigerenzer and others have demonstrated that such errors can often be reduced by stating problems in terms of

frequencies rather than probabilities (Cosmides & Tooby, 1996; Gigerenzer, 1991; Gigerenzer & Hoffrage, 1995). However, there are many instances in which the use of frequencies does not improve performance, and the reasons and necessary conditions for the observed effects remain subjects of debate (Gigerenzer, 1996; Gilovich & Griffin, 2002; Kahneman & Tversky, 1996; Mellers, Hertwig, & Kahneman, 2001). As a practical matter, there are many uncertainties in environmental assessment and decision making that cannot be realistically expressed in frequentist terms.

Estimated probabilities for events appear to be very sensitive to the ways in which those events are (or are not) described. For example, people often overlook possibilities that are not explicitly mentioned, even when they know better (Fischhoff, Slovic, & Lichtenstein, 1978). *Support theory* (Brenner, Koehler, & Rottenstreich, 2002; Tversky & Koehler, 1994) holds that the judged probability of an event increases when that event is *unpacked* into smaller components, and decreases when the complement of that event is unpacked. Such effects have been shown to influence decisions in a variety of domains.

Although verbal expressions of probability (e.g., "very likely") mean different things to different people and in different situations (Beyth-Marom, 1982; Budescu & Wallsten, 1995), they are often viewed as more natural than numerical probabilities. Most people prefer to communicate information about uncertainty verbally but prefer to receive such information numerically (Erev & Cohen, 1990; Wallsten et al., 1993). Perhaps surprisingly, evidence suggests that decision-making performance is not particularly sensitive to whether probabilities are expressed verbally or numerically (Budescu, Weinberg, & Wallsten, 1988; González-Vallejo, Erev, & Wallsten, 1994; Wallsten, 1990). However, procedures in such studies (and in others related to calibration and the communication of uncertainty; Karelitz & Budescu, 2004; Wallsten, Budescu, & Zwick, 1993) often require individualized scaling of verbal probabilities. Such procedures, and the assumption that the audience is aware of the resulting mappings, do not seem particularly well-suited to open participatory processes. The appeal of verbal expressions of uncertainty is apparently strong, however. For example, the use of numerical probabilities for standards of proof in legal settings is actively resisted, despite their documented superiority (Kagehiro, 1990; Kagehiro & Stanton, 1985).

Information Processing in Conflict and during Negotiations. As previously noted, humans are flexible information processors and a growing body of evidence supports the validity of dual process theories of reasoning and information processing. Although individuals may engage in deliberate processing to arrive at a particular judgment, in some instances (or for some individuals), evaluations of and affective response to a situation may emerge with little cognitive mediation or intervening appraisals (Loewenstein et al., 2001). This has implications for the impact of scientific evidence on judgments and the extensiveness of deliberation about the quality of arguments. During social conflict, selective biases in processing information can affect the quality of decisions and beliefs about the nature of the conflict (Bar-Tal, 2000), particularly when integrative complexity is necessary for conflict resolution (Wallbaum, 1993). Importantly, high levels of stress and perceived uncertainty lessen the likelihood of integrative complexity (Wallbaum, 1993), and make more likely judgment and information processing errors such as gross omissions in surveying alternatives, poor information search, failure to examine major costs and risks of preferred choices, and failure to comprehensively consider objectives (Wallbaum, 1993). The use of schematic information processing strategies during negotiations can prompt selective attention to and memory for facts, and can extend the process of conflict resolution (Carnevale & Pruitt, 1992; Halfacre et al., 2000). Characteristics of information

acquisition and use of knowledge during discussions of an environmental problem may help determine the quality of decisions that result from a participatory process.

Framing a Decision Problem and Options

Defining the Problem. Two of the most important factors underlying conflict about risk and environmental management may be an initial incompatible framing or structuring of the problem, and a discordant mental construction of the conflict among involved parties (e.g., Bazerman et al., 2000; Carnevale & Pruitt, 1992; Fischhoff, 1996; Fisher, 1991; Kunreuther & Slovic, 1996; Miller, 1999; Pellow, 1999). Many disputes about technological and environmental risks seem to involve basic disagreements about the definition and nature of the problem to be addressed (Bradbury, 1989; EPA, 1992; Kroll-Smith & Couch, 1994; Pellow, 1999; Snow et al., 1986; Thompson & Gonzalez, 1997). The framework imposed upon information and events affects the language and boundaries of discourse during social conflict (e.g., Abma, 2000; Dake, 1992; Entman, 1993; Pellow, 1999), and influences expectancies about involved groups (Cross & Rosenthal, 1999). By imposing order upon and giving structure to an environmental situation, frames-of-reference sensitize individuals to specific aspects of problems (e.g., Couch & Kroll-Smith, 1992; Kamenstein, 1996; Pellow, 1999; Rich et al., 1995) and determine what scientific evidence will be used (and judged as acceptable) to profile a community's situation (Halfacre, 2000; NRC, 1996; Pellow, 1999).

The framing of conflict and the level of congruity between cognitive/affective representations of decision problems help determine the degree of difficulty of conflict resolution (Bazerman et al., 2000). In fact, during successful negotiations, frames-of-reference often evolve and parties develop shared or compatible perspectives on the nature of the problem to be solved and beliefs about whether goals are compatible (Kruglanski, Bar-Tal & Klar, 1993). In the domain of environmental risk assessment and decision-making, a frequent source of disagreement between the public's perspectives and more traditional quantitative assessments is the definition of the problem to be addressed. As an illustration, in contrast to the probabilistic models that typically represent risk, many communities define risk problems as ethical, moral or value dilemmas (e.g., Bullard, 1990; Kamenstein, 1996; Stern & Dietz, 1994; Vaughan & Seifert, 1992), and often refer to risk management with terminology such as fairness, rights and moral obligations (e.g.,Bullard, 1990; Burke, 1993; Pellow, 1999; Sandman, 1993). In the context of decisions about environmental exposures, disputes frequently are about competing values (e.g., Kroll-Smith & Couch, 1991; Thompson & Gonzalez, 1995) and the criteria that should be used to judge the relevance and acceptability of information and solutions (Kunreuther & Slovic, 1995). Moreover, values seem to play a dominant role in determining risk perceptions and evaluations (e.g., Sjoberg, 2000).

A primary failure of more traditional technical risk characterizations is the lack of consideration of "protected values" of exposed populations, i.e., those that are resistant to trade-offs or compromise (e.g., Baron & Spranca, 1997; Burke, 1993; Kunreuther & Slovic, 1995; NRC, 1996). When individuals believe that decision processes have not adequately taken into account important values, then trust can be undermined, conflict exacerbated and negative affective reactions prolonged (e.g., Baron & Spranca, 1997; Fisher, 1991; Rich et al., 1995; Shah, Domke, & Wackman, 1996; Susskind, 1996; Thompson & Gonzalez, 1997). A re-framing of risk problems to incorporate the public's definitions, through participatory decision processes, may reduce conflict, negative affect and dissatisfaction with decisions because this process

explicitly recognizes and legitimizes values of importance to affected populations (NRC, 1996; Renn et al., 1995).

Framing and Constructed Preferences. Although it is still common for researchers to talk and write about *measuring* or *eliciting* people's preferences, values, or beliefs, it is now accepted that responses are very often *constructed* on the basis of the information that is available to respondents when they are asked to make a particular judgment or decision (Gregory, Lichtenstein, & Slovic, 1993; Payne, Bettman, & Johnson, 1992, 1993; Payne, Bettman, & Schkade, 1999; Slovic, 1995). The result is that people's responses to seemingly straightforward questions may vary greatly as a function of question wording, response format, information availability and presentation, and context. Slovic (1995) summarized this state of affairs as follows:

> "Preferences appear to be remarkably labile, sensitive to the way a choice problem is described or 'framed' and to the mode of response used to express the preference . . . These failures of invariance [over formally equivalent procedures] have contributed to a new conception of judgment and choice in which beliefs and preferences are often constructed—not merely revealed—in the elicitation process" (p. 365).

A classic *framing effect* involves manipulation of respondents' reference points by describing the possible outcomes of a risky decision in terms of either gains (e.g., lives saved) or losses (e.g., lives lost; Tversky & Kahneman, 1981). Similarly, respondents may appear to prefer one alternative over another when asked in one way (e.g., for the highest price they would be willing to pay for each of the alternatives), while exhibiting the opposite preference when asked in a different way (e.g., choosing between the two alternatives). Such *preference reversals*, which have also been demonstrated for comparisons of environmental and market goods (Irwin et al., 1993), appear to result in part from different features of the alternatives being more salient or prominent in different judgment and choice tasks (Slovic, 1995; Tversky, Sattath, & Slovic, 1988; Tversky, Slovic, & Kahneman, 1990). More recently, Hsee (1996; Hsee et al., 1999) has demonstrated that attribute weights often depend on whether alternatives are evaluated separately or jointly, and has argued that joint evaluation may be problematic when the chosen alternative will be experienced separately.

The fact that preferences and judgments are sensitive to such variations suggests that particular care be given to the framing of judgment and decision tasks and to the presentation of information in any analytic-deliberative process. In many instances, it may be advisable to frame problems and elicit judgments in more than one way, so that participants have the opportunity to think through the relevant issues from multiple perspectives.

Advances in Risk Perception Research

The NRC noted the relevance of risk-perception research in *Understanding Risk* (Stern and Fineberg, 1996). More recently, Slovic (2000a) has compiled much of this research in a single, accessible volume with an introductory chapter that puts the work in historical perspective. In this section, we highlight a few important developments that have occurred since the publication of *Understanding Risk* and which seem particularly germane to participatory processes for environmental assessment and decision making.

The Affect Heuristic

Living with uncertain hazards that threaten valued goals can lead to high levels of worry, fear and concern (Adeola, 2000; Rich et al., 1995), and can have a devastating impact on the lives of affected populations (e.g., Bohm & Pfister, 2000; Kroll-Smith & Couch, 1991; Matthies,

Hoger, & Guski, 2000). An exposure situation, and its potential to disrupt the quality of life, can evoke strong feelings and behaviors including hypervigilance, outrage or anger, anxiety and fear, uncertainty, apathy, sadness and a decreased sense of efficacy or control (e.g., Rich et al., 1995; Kroll-Smith & Couch, 1991; NRC, 1996). As risk information is disseminated throughout a community and an issue becomes the focus of deliberations, feelings of anger, fear and sadness are common and frequently quite extreme (e.g., Adeola, 2000). For example, when preliminary decisions are made about a site-specific environmental problem in a community, in the course of information exchanges representatives of regulatory agencies and industry often encounter an intensely angry, fearful and outraged public (e.g., Rich et al., 1995; Vaughan & Seifert, 1992). These strong emotions influence how individuals interpret exposure-health relationships and process relevant information (Covello et al., 2001; Slovic, 1999). Responses to environmental risks may actually result more from emotional experiences than extensive deliberation or cognitive evaluations (e.g., Lerner & Keltner, 2000; Loewenstein et al., 2001). In many contexts, an "affective heuristic" may better represent the nature of reasoning and the process of perceiving risk (e.g., Finucane et al., 2000) than rule-based, analytical cognition (Shanovich & West, 2000). Although risk judgments and choices initially were considered almost exclusively in terms of cognitive processes, many scholars now recognize the crucial role that emotion plays in related behaviors, attitudes and the meaning ascribed to a risky circumstance (e.g., Bohm & Pfister, 2000; Kahneman, 2003; Lerner, Gonzalez, Small, & Fischhoff, 2003; Lerner & Keltner, 2000,2001).

For example, anger vs. sadness may be the predominant emotion experienced in a decision situation that presents the possibility of a loss when there is an attribution of intentional harm (e.g., Levine, 1996). Indeed, when individuals are threatened by an environmental or technological hazard directing blame and responsibility towards a clearly identifiable agent is strongly associated with a sense of outrage and anger (e.g., Sandman, Miller, Johnson & Weinstein, 1993). Intense affect can act as a useful signal to take immediate action (e.g., Cacioppo et al., 1999; Lazarus, 1991; Loewenstein et al., 2001), but in some contexts impairs effective responding (DiGiovanni, 1999; Holloway et al., 1997; Loewenstein et al., 2001). For a significant number of individuals, uncertain environmental risk situations extend the experience of fear and of being in the warning and threat stage of the adaptation process (Kroll-Smith & Couch, 1991).

Specific negative emotions have implications for conflict resolution and the process of deliberation. Anger, for example, often leads to a narrower set of preferences for action (Bazerman et al., 2000), and preferences of individuals tend to be different than when fear is the predominant emotion experienced (Lerner et al., 2002). In addition, specific perspectives on an environmental issue may differentially evoke particular emotions. A justice framework in particular has been shown to lead to more intense and durable emotional responses, and increase the likelihood of specific emotions such as anger, disgust and fear (e.g., Mikula, Scherer, & Athenstaedt, 1998). For situations that lead to strong emotions, the difficulty of a public participation process for environmental decision-making is likely to be related to the reasoning and judgment strategies that are more likely given a context of intense negative emotions.

More Evidence for the Affect Heuristic. Logically, there should be a positive relationship between the risks and benefits of different technologies or activities, because technologies or activities that have large risks and small benefits should be relatively uncommon. However, the original psychometric study of risk perception (Fischhoff et al., 1978) noted that there was a slight negative relationship between judgments of risk and judgments of benefit. Years later,

Alhakami and Slovic (1994) noted that this relationship is explained by people's affective reactions to hazards (e.g., ratings on a simple good/bad scale), such that more negative affective reactions are associated with judgments of greater riskiness and lower benefit. Slovic et al. (2002, 2004) reported similar results from an earlier (1999) study of toxicologists.

In an important pair of studies, Finucane et al. (2000) showed that the negative relationship between judgments of risk and benefit is mediated by affective reactions to hazards. In their first study, the negative relationship between risk and benefit was much stronger when there was time pressure, presumably because this condition favored quick affective assessments over more analytic processes. In their second study, manipulations of one aspect of a hazard (e.g., its riskiness) affected the nonmanipulated aspect (e.g., benefit) in the opposite direction, as would be expected if the manipulation altered participants' global evaluations of the hazards. In both studies, the effects were significant when tested within participants across risks and within risks across participants.

Slovic et al. (2002, 2004) summarized additional evidence that is consistent with the importance of affective reactions in risk perception and commented on the close relationship between the affect heuristic, the risk-as-feelings approach (Lowenstein et al., 2001), and dual-process theories of information processing (Stanovich & West, 2000; Reyna, 2004). For example, Lowenstein et al. suggested that affective processing may sometimes lead to overreaction to stimuli that are known to be safe (e.g., caged snakes and spiders) but underreaction to other stimuli that are indeed risky (e.g., automobiles, hamburgers, smoking, and unsafe sex). In a seemingly related vein, Sjöberg (1998), Rundmo and Sjöberg (1998), and Baron, Hershey, and Kunreuther (2000) have noted the importance of worry in determining overall risk evaluations and people's desires for risk reduction, although Sjöberg's studies focus only on differences among respondents (see the methodological section below). It remains to be seen whether longer-term experiences of worry are related to people's initial affective assessments of hazards.

The fact that affective dimensions are predictive of risk and benefit judgments does not necessarily imply that they would be good attributes for describing risks in the context of an analytic-deliberative process. In particular, attributes such as dread, worry, and attitude toward a hazard (Sjöberg, 2000) are not characteristics of the hazards themselves; they are human reactions to hazards. As a result, they might be more appropriately treated as dependent variables than as predictor variables (or perhaps as mediating variables between risk characteristics and other judgments, as in Baron, Hershey, and Kunreuther, 2000). In addition, such attributes are difficult to quantify without survey procedures and are therefore not particularly useful for anticipating public response to hazards that have not yet been studied in that manner. For this reason, other more tangible operationalizations (e.g., the number of people that could be killed in a single event, as a measure of catastrophic potential) may prove more practical in some settings.

Perceptions of Ecological Risks

It is well known that people perceive risks as multidimensional. Psychometric approaches have been used to study the relationships among the attributes of risks and to relate risk perceptions to judgments of riskiness and acceptability (e.g., Fischhoff et al., 1978; Slovic 1987, 2000a), as noted in *Understanding Risk* (Stern & Fineberg, 1996). Several recent studies have addressed the dimensions of ecological risks more specifically (Lazo, Kinnell, & Fisher, 2000; McDaniels, Axelrod, & Slovic, 1995, 1996; McDaniels et al., 1997; Willis et al., in press). The

results of these studies are very consistent, and indicate that as many as six different dimensions may be needed to account for perceptions of such risks. Using Willis et al.'s (in press) labels, these dimensions are *ecological impacts*, *human impacts* (impacts on humans), *human benefits*, *aesthetic impacts*, *scientific understanding*, and *controllability*.

As in previous studies of risk perception, these dimensions are related to judgments of the riskiness and acceptability of hazards, although the details of these relationships vary slightly across studies. Greater ecological impacts, greater human impacts, and lower human benefits are consistently associated with higher judgments of riskiness, whereas the relationship between controllability and riskiness is usually not significant. Perhaps surprisingly, greater knowledge of ecological risks has been positively associated with riskiness in *all* of these studies (see Baron, Hershey, & Kunreuther, 1998, and Morgan et al., 2001, for similar results). As might be expected, more negative aesthetic impacts also appear to be associated with greater riskiness, although this relationship has been assessed only in Willis et al.'s (in press) two studies.

As suggested by Fischhoff, Watson, and Hope (1984) and reiterated in *Understanding Risk* (Stern & Fineberg, 1996), attributes from psychometric analyses may be incorporated into formal multiattribute procedures for evaluating risks. In one demonstration of this approach, Willis et al. (2004) developed a comprehensive but manageable set of attributes for describing risks to health, safety, and the environment, and used these attributes in analytic-deliberative exercises for ranking risks (i.e., in a comparative risk assessment).

Despite these advances, the list of relevant psychometric dimensions may not yet be exhausted. For example, perceived interference with nature appears to be related to riskiness judgments for nuclear issues (Sjöberg, 2000). This finding is consistent with previous research indicating that people are more concerned about environmental damage when it results from human actions than when it results from natural causes (Kahneman & Ritov, 1994; Kahneman et al., 1993; DeKay & McClelland, 1996). As was the case for the initial psychometric dimensions, some authors have questioned the rationality of such distinctions (e.g., Baron, 1997).

A Methodological Issue for the Psychometric Approach

One critique of the traditional psychometric approach is that it the data are usually averaged over respondents prior to analysis. Such averaging obscures interesting variation among respondents and inflates relationships between the psychometric dimensions and other variables such as riskiness and acceptability (Gardner et al., 1982; Harding & Eiser, 1984; Vlek & Stallen, 1981). In multiple regressions, for example, common psychometric dimensions usually explain only 20–30% of the variation in riskiness judgments when disaggregate data are used (Gardner & Gould, 1989; Marris et al., 1997; Sjöberg, 1996, 2000), compared to 70–90% when aggregate data are used. However, almost all of the studies reporting the lower values have taken an individual-differences approach similar to that used in attitude-behavior research. Thus, these studies differ from the traditional psychometric approach not only in the level of analysis (disaggregate rather than aggregate), but also in the primary focus of analysis (differences among respondents rather than differences among risks). Two recent studies in which these variables were crossed indicated that changes in the level and focus of analysis both contribute to the decrease in explanatory power, and that the sizes of the two effects are roughly equal (Bronfman et al., 2005; Willis et al., in press).

One important result of this line of research is that psychometric dimensions do not differentiate among respondents as well as they differentiate among risks. Thus, these

dimensions may be somewhat less useful in understanding which people are most concerned about a particular risk than in understanding which risks people are generally most concerned about. However, if the primary goal is to differentiate among risks (as in comparative risk assessment; Jones & Klien, 1999; Minard, 1996), it is still possible to use psychometric dimensions in a way that allows for individual differences. A particularly promising method uses aggregate-level data to determine the dimensions of the risk space (as in the traditional psychometric approach), but represents each individual's (or group's) riskiness judgments as a separate vector in this common space (Arabie & Maschmeyer, 1988; Bronfman et al., 2005; Vlek & Stallen, 1981; Willis et al., in press).

Summary

The final chapter on risk perception has not yet been written. Theoretical and methodological advances continue to yield valuable insights into people's psychological responses to hazardous technologies and activities. Because these response patterns have important implications for characterizing and evaluating risks in participatory processes for environmental assessment and decision making, agencies and organizations that conduct or participate in such processes are encouraged to follow these developments closely.

Cross-Cultural Perspective on Affect, Risk Perceptions and Reasoning Strategies in Environmental Assessment and Decision-Making

At this point in the review, we have treated psychological phenomena that influence judgment, reasoning and decision-making as if these processes apply equally across groups. Yet, we know that cultural orientations and traditions provide an important context for reasoning, risk perceptions and decision-making (e.g., Nelkin, 1989; Sjoberg, 2002). Cultural beliefs and values influence basic cognitive and motivational processes that can influence judgments and decision-making about risk (Langford et al., 2000). A major challenge for implementing more participatory strategies for environmental decision-making in the United States is designing reasonable processes in a culturally diverse and heterogeneous society.

Certain social groups bring to the decision process problem-solving perspectives, expectations, responses and values that traditionally have not been incorporated into assessment paradigms (Stern & fineberg, 1996; Vaughan & Seifert, 1994). Cross-national comparisons of risk judgments and responses, as well as studies of different social groups within the United States, consistently have found significant ethnic differences in risk responses, perceptions and preferences (e.g., Bechtel, et al., 1999; Bord & O'Connor, 1997; Flynn, Slovic, & Mertz, 1994; Kleinhessenlink & Rosa, 1994; Slovic, Kraus, Lappe, & Majors, 1991; Vaughan & Nordenstam, 1991; Weber & Hsee, 1998). In addition, culture influences the affective significance of a conflict (Kruglanski et al., 1993), and judgments about what are acceptable ways to resolve disputes (Bazerman et al., 2000). Individuals with different cultural orientations towards conflict and problem-solving may not share some of the most basic assumptions about what are the crucial issues to address during discussions (Bazerman et al., 2000). Psychological responses to environmental problems develop and emerge relative to prior experiences, current life circumstances and a priori belief and value systems (Sern & Fineberg, 1996; Vaughan & Seifert, 1992, 1995a). The culturally derived value priorities of individuals impose order upon and give structure to an environmental or conflict situation (e.g., Couch & Kroll-Smith, 1992; Kamenstein, 1996; Pellow, 1999; Rich et al., 1995).

One of the fundamental goals of participatory environmental decision-making is to achieve effective partnerships between regulatory agencies and the public, particularly for those communities most affected by environmental hazards. Although minority and economically disadvantaged communities are those most vulnerable to the effects of environmental risks (e.g., Kuehn, 1996), and are most likely to be exposed to significant health hazards when compared to others (e.g., Bullard, 1990), they are the populations most difficult to engage in participatory risk management (Pellow, 1999). The difficulty may lie with a limited understanding of the subjective meaning ascribed to decision problems by diverse populations. For example, although many communities define environmental risk issues as moral or value dilemmas (e.g., Bullard, 1990; Kamenstein, 1996; Stern & Dietz, 1994; Vaughan & Seifert, 1992), this rhetoric is especially likely in ethnically diverse and lower income communities whose structuring of risk problems frequently reflects a justice and equity frame (e.g., Bullard, 1990; Pellow, 1999; Vaughan & Seifert, 1992). Certain cultural groups embrace ideological belief systems that increase the likelihood of defining particular events in reference to a moral frame (Mesquita & Fridja, 1992). This can lead to a different emphasis on aspects of situations and subsequently to variation in appraisals and event-related emotions (e.g., Mesquita & Fridja, 1992). A justice framework in particular has been shown to lead to more intense and durable emotional responses (e.g., Mikula, Scherer, & Athenstaedt, 1998), and African-Americans in particular are more likely than others to evaluate and structure risk problems in terms of fairness, equity and justice (e.g., Vaughan & Seifert, 1992). A justice framework increases the likelihood of certain appraisals (e.g., attributions of blame) and fosters the expression of specific emotions such as anger, disgust and fear (e.g., Mikula, Scherer, & Athenstaedt, 1998). Moreover, even if groups are similar in emphasizing fairness to evaluate risk, notions of what is fair in a situation vary among cultural groups (Langford et al., 2000; Scherer, 1997). For environmental and risk problems, an individual's focus on ethical principles that may be violated by an exposure situation, potential losses or the assignment of responsibility for consequences has implications for both the intensity and type of emotions (and appraisals) that predominate (Bohm & Pfister, 2000; Scherer, 1997). This fundamental relationship between culture and how an individual assigns meaning to experiences suggests that cultural phenomena may influence risk-related cognition and emotion, and their interrelationship, through additional mechanisms (Miller, 1999).

Valuation of Outcomes and Other Attributes of Decision Situations

Several additional findings regarding how people evaluate outcomes, probabilities, attributes, and other aspects of decision situations are relevant to the analytic-deliberative process. Here is a listing of several well-established findings that seem particularly germane.

Bounded Rationality

Formal models of decision making, such as subjective expected utility theory (SEU) and multiattribute utility theory (MAUT), are often advocated as prescriptions for making better decisions and used as benchmarks against which performance is judged. However, such models may be difficult for untrained individuals to implement when decisions are complex or when there are constraints on their ability or willingness to engage in exhaustive analysis. Fortunately, many simpler strategies that do not live up to strict principles of rationality perform reasonably well in a variety of real-world situations. For example, Simon (1955, 1956) used the term

satisficing (as opposed to *optimizing*) for the strategy of stopping one's search through a set of alternatives when a good-enough alternative is found.

Such processes can save the decision maker a great deal of time and effort when the alternatives possess many different attributes or when the set of alternatives is large or not clearly defined. Some of these strategies (e.g., *elimination by aspects*; Tversky, 1972) allow one to quickly pare down the decision space so that more attention can be devoted to the better options. Other *fast-and-frugal* heuristics (e.g., *take the best*; Gigerenzer & Goldstein, 1996; Gigernezer, Todd, & ABC Research Group, 1999) perform remarkably well with very little cognitive effort, although the performance of such algorithms decreases when desirable attributes are negatively correlated across alternatives (Fasalo, McClelland, & Todd, in press). The approach taken by Gigerenzer and colleagues echoes earlier efforts by Payne, Bettman, and Johnson (1992, 1993), who demonstrated that many relatively simple strategies perform almost as well as the benchmark MAUT evaluation when there is ample time to make a choice, and much better than MAUT when time constraints are imposed. The term *bounded rationality* is used to convey the fact that cognitive limitations and situational constraints often (some would say always) restrict people's ability or willingness to engage in effortful decision-making processes. Recent discussions appear in Gigerenzer and Seltin (2001) and in Hastie and Dawes (2001). North and Renn (chapter X in this volume) review formal models and decision tools that may be very useful in helping participants in analytic-deliberative processes to implement more normatively defensible decision-making procedures.

Loss aversion. People often make choices as if the disutility associated with a loss is much greater than the utility associated with an equivalent gain. This *loss aversion* is a key feature of Kahneman and Tversky's prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1991, 1992). As noted by the NRC in *Understanding Risk* (Stern & Fineberg, 1996), loss aversion provides an explanation for framing effects involving medical decisions (McNeil et al. 1982), public health decisions (Tversky & Kahneman, 1981, 1984), and environmental decisions (Gregory, Lichtenstein, & MacGregor, 1993). More generally, loss aversion often translates into a preference for the status quo (*status-quo bias*; Samuelson & Zeckhauser, 1988), a preference for inaction over action (*omission bias*; Baron, 1992; Ritov & Baron, 1990, 1992; Spranca, Minsk, & Baron, 1991), or overvaluation of whatever one happens to possess (the *endowment effect*; Kahneman, Knetsch, & Thaler, 1990, 1991; Knetsch, 1989).

Insensitivity to magnitude or scope. Contingent valuation methods for determining the value of environmental resources are controversial, in part because respondents are notoriously insensitive to the amount or magnitude of the good (Baron, 1997; Kahneman & Knetsch, 1992; Kahneman et al., 1999). This is particularly true when goods or programs are evaluated in isolation (as in between-participants designs) rather than in comparison to one another (as in within-participant designs). Hsee and Rottenstreich (2004) reported that value is essentially a step function of scope when judgments are based mostly on feelings, but a more linear function of scope when judgments are based mostly on calculation.

Difficulty in valuing future outcomes. In many instances, people do not appear to be very good at predicting how happy or unhappy they would be if things were different. In other words, *anticipated utility* is often different from *experienced utility* (Hsee et al., 2003; Kahneman, 1994, 1997; Loewenstein, O'Donoghue, & Rabin, 2003; Soman, 2003). In particular, there appears to be a pervasive lack of appreciation for people's ability to adapt to new states or situations,

leading to overestimation of the magnitude of positive or negative changes in utility (Boyd et al., 1990; Brickman, Coates, & Janoff-Bulman, 1978; Ubel et al., 2001).

Nonlinear decision weights. Expected value and expected utility models require that possible outcomes be weighted by their probabilities linearly. However, peoples' choices are often more consistent with the use of nonlinear weights. Specifically, outcomes with low probabilities are often overweighted and outcomes with high probabilities are often underweighted (Gonzalez & Wu, 1999; Kahneman & Tversky, 1979, Tversky & Fox, 1995; Tversky & Kahneman, 1992; Wakker, 2004; Wu & Gonzalez, 1996). Such nonlinearities may provide a partial explanation for why traditional expectation-based metrics for risk are viewed as inadequate or misleading by members of the general public, who often place relatively more emphasis on low-probability high-consequence events (i.e., catastrophic potential).

Tendency to view decisions in isolation. When combined with loss aversion, the tendency to view decision situations as unique may lead to a series of choices that is clearly inferior when judged on the basis of aggregate outcomes (Benartzi & Thaler, 1999; Kahneman & Lovallo, 1993; Read, Loewenstein, & Rabin, 1999; Redelmeier & Tversky, 1992). In most cases, it is arguably rational to adopt a broader perspective in which individual decisions are seen in the context of other related decisions. This is particularly true when risks are cumulative (e.g., Doyle, 1997; Slovic, 2000b; Svenson, 1984) or synergistic (Hampson, Andrews, & Barckley, 2003).

Mechanisms for Improving Judgment and Decision Making

One of the primary reasons for studying judgment and decision making (perhaps *the* primary reason) is to discover ways to help people make more accurate judgments and better decisions. Many researchers have attempted to improve performance by creating contexts or designing strategies that reduce the incidence of errors and inconsistencies. It is useful to review such efforts here because they may provide guidance for improving the quality of information use and reasoning in analytic-deliberative processes.

Debiasing

Attempts to improve judgment and decision making by reducing the influence of heuristics and other simplistic strategies have often been labeled *debiasing* techniques. Some authors have objected to this term because they do not agree that the response tendencies in question result from biases rather than from poorly structured or poorly worded tasks, or from incorrect or incorrectly applied normative models. Nonetheless, the literature on debiasing is informative in that it helps to specify the extent to which common response tendencies are sensitive to changes in tasks and variables.

In the original review of the debiasing literature, Fischhoff (1982) focused only on hindsight bias and overconfidence (or more generally, miscalibration). Although these two biases may not be the most relevant for analytical-deliberative processes (one might argue that overconfidence is much more relevant than hindsight bias), the general pattern of results for debiasing remains instructive.

Hindsight bias. Hindsight bias is the tendency to overestimate the probability that an event could have been predicted before it actually occurred, and also to claim (or "remember") incorrectly that one had assigned a higher probability to the event in foresight. In other words,

people often think that that they "knew it all along" even if they didn't, and that others should have known it all along even if they couldn't (Fischhoff, 1975).

Fischhoff's (1982) review indicated that almost all attempts to reduce hindsight bias had been unsuccessful. A partial list of failed approaches included the following: (a) using judgments of surprise rather than judgments of probabilities, (b) using more homogeneous items to allow for more extensive processing of the content domain, (c) instructing participants to work harder, (d) using events that participants actually judged in foresight, (e) having participants assess the probability of an event's recurrence rather than its initial occurrence, and (f) having participants estimate the probabilities that other people would have given in foresight (see the original review for citations to specific studies). The only successful strategy was to require participants to provide possible explanations for the complementary event that did not occur (Slovic & Fischhoff, 1977). Apparently, engaging in counterfactual thinking made the event that did occur seem less inevitable. Fischhoff (2002) noted that more recent reviews of hindsight studies largely confirm this pattern of results.

Overconfidence. Overconfidence has typically been assessed in one of two ways. In the first method, participants indicate the probability that their answers to particular two-alternative choice questions are correct (i.e., their level of confidence in each answer). Questions for which a respondent indicates similar levels of confidence are grouped together and the proportion of correct responses is computed for each category. In many situations, the percentage of correct responses in each category is lower than the stated confidence level, indicating overconfidence. In the second method, participants are asked to make high and low estimates of many quantities (e.g., the population of a particular city) such that they have a specific level of confidence (e.g., 95%) that the true value lies between the two estimates. Typically, the proportion of true values that actually lie within these intervals is much lower than the confidence level, again indicating overconfidence.

The results of Fischhoff's (1982) review were only slightly more positive for overconfidence than for hindsight bias. Unsuccessful attempts to reduce overconfidence included: (a) using homogeneous items rather than general knowledge questions; (b) raising the stakes by using inherently important tasks, such as students' own test answers; (c) offering real monetary gambles based on stated confidence intervals; (d) focusing only on items for which participants reported 100% confidence; and (e) using verbal statements of likelihood rather than numerical probabilities. Partially successful strategies included (f) telling respondents that it may be impossible to determine the correct answer and (g) instructing them to "spread the tails" of their distributions. The most successful strategies were (h) providing intensive, personalized feedback on respondents' performance (Lichtenstein & Fischhoff, 1980) and (i) requiring that respondents list reasons why their preferred answer might be incorrect (Koriat, Lichtenstein, & Fischhoff, 1980). Of the two successful strategies, the first is consistent with the excellent calibration observed for weather forecasters (e.g., Murphy & Winkler, 1977), race odds-makers (e.g,. Hausch, Ziemba, & Rubenstein, 1981), and expert bridge players (Keren, 1987)—groups that receive extensive training or practice with large amounts of feedback. The second is essentially identical to the successful approach for eliminating hindsight bias.

Other factors are also known to affect the presence of overconfidence, most notably the difficulty of items. Typically, overconfidence is observed for difficult items, whereas underconfidence is observed for easy items (e.g., Lichtenstein & Fischhoff, 1977; Yates, 1990). Gigerenzer, Hoffrage, and Kleinbolting (1991) and Juslin (1994) have suggested that

overconfidence is eliminated when items are generated in a representative manner (random sampling from a defined domain) rather than selectively. However, such procedures do not always eliminate overconfidence, and item difficulty may provide an alternative explanation for some observed results (Griffin & Tversky, 1992). Despite these discrepancies (for a brief summary, see Mellers, Schwartz, & Cooke, 1998), the successful debiasing procedures identified by Fischhoff (1982) are still instructive. Fischhoff (2002) noted the need for a metaanalysis of debiasing efforts related to overconfidence and miscalibration.

Three causes of error. Arkes (1991) suggested that the successfulness of techniques for improving judgments and decisions is logically related to the causes of the errors in question. He grouped errors into three categories: *strategy-based errors*, *association-based errors*, and *psychophysically based errors.* (He cautioned that these categories be used to classify causes rather than errors, because errors may be multiply determined, but found these labels useful nonetheless.)

Arkes (1991) described strategy-based errors as those arising from incomplete consideration of available information. Such strategies may be highly adaptive when the stakes are low, the task is complex, and available resources are limited (e.g., by time pressure; Payne, Betteman, & Johnson, 1992, 1993). Arkes argued that many such errors can be reduced by "raising the stakes." For example, errors in the judgment of covariation appear to be reduced when motivated respondents use more of the data and engage in more systematic processing. In other tasks, greater personal stakes lead respondents to consider the merits of arguments for policy alternatives, not just the number of arguments on either side (e.g., Petty & Cacioppo, 1984). In addition, making respondents accountable for their judgment processes often has similar effects on the depth of processing (see the section on accountability below for a more detailed review).

Association-based errors are those that arise from using simple, intuitive heuristics based on associations in memory. These include most of the effects from the heuristics-and-biases literature: (a) hindsight bias (as discussed above); (b) overconfidence (ditto); (c) biases and errors resulting from similarity or representativeness [e.g., *conjunction errors*, in which $P(A \text{ and } B)$ is rated as greater than $P(A)$]; (d) *explanation bias*, in which explaining particular outcomes leads to higher probability estimates for that outcome; (e) *confirmation bias*, in which the selective search for and utilization of information provides inappropriate support to a focal hypothesis; and (f) other effects involving the suboptimal use of conditional probabilities (e.g., *pseudodiagnosticity*). Arkes (1991) reported that incentives alone are usually unsuccessful at reducing the incidence of such errors, perhaps because respondents find it difficult to generate additional relevant evidence or to apply better problem-solving strategies (although apparently this is not always the case; see the discussion of accountability below). He suggested that a more successful approach is to encourage different associations that lead to a more balanced assessment of the situation in question. In particular, requiring respondents to consider alternative conclusions and requiring them to state reasons that might be used to support such conclusions appears to lower the incidence of association-based errors.

Psychophysically based errors are related to the prospect-theory value function (Kahneman & Tvesky, 1979; Tversky & Kahneman, 1992), which has a steeper slope below the reference point and diminishing marginal differences in value as one moves away from the reference point. Such errors include: (a) weighting sunk costs (previous expenditures or commitments) in current decisions; (b) tendencies to anchor on arbitrary numerical values in judgment tasks; (c) certain framing effects (e.g., the well-known Asian disease problem); and (d) insufficient attention to

marginal costs when costs are already large. Arkes (1991) again reported that incentive are ineffective at reducing these errors. In particular, weighting sunk costs is known to occur in decisions regarding multimillion-dollar projects (although possibly for political as well as cognitive reasons). He suggested a number of possible solutions, the most relevant of which are making respondents aware of opportunity costs (i.e., other possible uses of the resources in question) and framing problems in more than one way. More precisely, he suggested reframing problems or strategically shifting reference points to achieve desired goals (e.g., to begin or maintain a diet), but such manipulations are likely to be inappropriate for many participatory processes.

Lastly, Arkes (1991) noted that *specific* training relevant to particular errors is often successful (e.g., accounting practices have no role for sunk costs) even though more general training (e.g., in economics) may not be.

Extensions and qualifications. Although the Fischhoff (1982) and Arkes (1991) reviews are somewhat dated, more recent research confirms that considering additional alternatives is useful in reducing hindsight bias, explanation bias, and overconfidence (Hirt & Markaman, 1995; Hirt, Kardes, & Markman, 2004), at least when plausible alternatives are relatively easy to generate. However, if generating reasons why an event might have turned out differently is perceived as difficult (e.g., when respondents are required list 10 to 12 reasons rather than two to four reasons), hindsight bias may be amplified rather than attenuated (Sanna & Schwarz, 2003; Sanna, Schwarz, & Stocker, 2002). Finally, there is some evidence that actively seeking information and explanations for other possible outcomes also reduces biases in group decisions (e.g., Kray & Galinsky, 2003).

Summary of debiasing research. The results cited above tell a relatively consistent story. They suggest that many biases result from information processing that is relatively intuitive and overly focused on specific alternatives or outcomes. Getting respondents to engage in more analytical thinking—particularly analytical thinking about reasons that would support other choices or predictions—is a remarkably useful debiasing strategy in many cases. In some instances, respondents may engage in such thinking in response increased stakes, but this is by no means guaranteed. Prompting respondents to think about other potentially relevant information (e.g., other possibilities, opportunity costs) may be required. Specific training and feedback also appears to be a viable option in some circumstances.

Accountability

Over the years, accountability has been suggested as a mechanism for improving performance in a wide range of tasks, including judgment and decision-making tasks. Thus, accountability may be considered a debiasing technique. We consider it separately to highlight its potential importance in participatory analytic-deliberative processes. Accountability is not a panacea, however. A large body of research indicates that it leads to the desired improvements only in specific circumstances, and sometimes it makes things worse. To our knowledge, Lerner and Tetlock (1999, 2003) have provided the only extensive reviews of this literature. This section relies heavily on their work.

Because the studies reviewed by Lerner and Tetlock (1999; 2003) focused on the behavior of individual participants, caution should be used in generalizing to the effects of accountability in group settings. In addition, accountability is related to several other aspects of social situations. Specifically, people who are being held accountable know that their behavior or performance is

being observed, that their products or actions will be linked to them, and that these products or actions will be evaluated. Thus, is very difficult to separate the effects of accountability from the effects of these other embedded manipulations.

Three key distinctions in the accountability literature are whether study participants learn of their accountability before or after they consider information and draw conclusions, whether the views of the audience to whom they are accountable are known, and whether the audience is more concerned with the outcome of the decision or the process by which the decision is made.

When participants learn that they are accountable only after considering information and making decisions (*postdecisional accountability*), they are likely to engage in *defensive bolstering* of the chosen course of action. One example of such behavior is the sunk-cost effect (Arkes, 1996; Arkes & Blumer, 1985), in which people are more likely to stick with a previously determined course of action if they have invested time, effort, or money into an endeavor, even if a forward-looking perspective suggests that this course of action is a poor choice. However, when participants learn that they are accountable before they consider information and make decisions (*predecisional accountability*), such effects are attenuated (e.g., Simonson & Nye, 1992; Simonson & Staw, 1992).

When the views of an audience are known to participants (or can be guessed), participants are likely to shift their own views to be consistent with those of the audience, although the extent of such strategic shifts depends individual differences among participants (e.g., the extent to which they are high on scales of self-monitoring and social anxiety; Snyder, 1974) and the size of the audience (Brockner, Rubin, & Lang, 1981). Such strategic shifts are common even when the participants feel substantial personal involvement, as might occur for ethical dilemmas (Brief, Dukerich, & Davon, 1991).

When the audience is primarily interested in the process by which a decision is made (*process accountability*) rather than the outcome of that decision (*outcome accountability*), participants are more likely to engage in evenhanded and effortful consideration of the available options and less likely to engage in defensive justification of their chosen alternative or course of action (Simonson & Staw, 1992). There is some evidence that process accountability leads to into improved performance relative to outcome accountability (e.g., improved accuracy and calibration in judgment tasks; Siegel-Jacobs & Yates, 1996).

To summarize, extensive and reflective information processing appears to be most likely when participants know that they will be held accountable at the outset of the judgment task, when they do not know the opinions of those who will evaluate their efforts, and when they are accountable for their reasoning processes rather than their final judgments. Lerner and Tetlock (1999) also noted that the legitimacy and knowledge of the audience have similar effects.

The majority of research on the effects of accountability on judgment and choice has involved predecisional accountability to an audience with unknown views. Lerner and Tetlock (1999, 2003) reported that such manipulations most often attenuate response tendencies that are commonly labeled as biases. However, accountability may have no effect on such tendencies in some circumstances, and it may amplify them in others. Fortunately, there is a sensible pattern to these results.

Situations in which accountability attenuates response tendencies. As noted in the earlier review of dual-process theories of information processing, many heuristics and biases result from

the use of what Stanovich and West (2000; OTHERS?) refer to as System 1. When response tendencies in the absence of accountability stem from a lack of effort or a lack of insight into one's judgment processes (or both), predecisional accountability to an audience with unknown views attenuates those tendencies. Evidence for this conclusion comes from 40 separate tests in a variety of studies involving 16 different response tendencies. For example, this type of accountability (a) reduces biases toward distributional as opposed to situational attributions for others' behavior (the *fundamental attribution error*); (b) reduces tendencies to engage in *anchoring* on arbitrary numerical values in judgment tasks; (c) decreases overconfidence and improves calibration in probabilistic judgment tasks; (d) reduces conjunction errors; (e) reduces the weight given to sunk costs; and (f) reduces tendencies toward *groupthink* (see Lerner & Tetlock, 1999, for a complete table of effects, with citations).

The reason for these effects is that accountability of the type studied encourages participants to engage in more effortful and self-critical information processing. In other words, there is a shift from System-1 processing (the default) to more analytical System-2 processing. This additional effort improves performance because relevant knowledge and superior analytical strategies are readily apparent to most participants. Although one might not expect this to be the case for sunk-cost effects, the studies reviewed involved MBA students who had specific training in applying expected utility theory (a forward-looking, consequentialist approach) to decisions about future investments (Simonson & Nye, 1992; Simonson & Staw, 1992).

Situations in which accountability has no effect on response tendencies. In some situations, however, invoking System 2 does not help, because participants do not have the requisite knowledge or skill to apply a more defensible strategy (Kahneman, 2003). Lerner and Tetlock (1999, 2003) reported this result for only four response tendencies: (a) insensitivity to base rates when making probability judgments about specific cases; (b) overweighting of causal information relative to other diagnostic (but noncausal) information; (c) insensitivity to sample size, in which the relationship between sample size and the precision of estimates based on sample data is ignored; and (d) preference reversals, in which different elicitation procedures imply different orderings of alternatives.

In the first three cases, correction of these tendencies requires specialized knowledge from probability theory or statistics. In the fourth case, it may not be necessary for participants to understand that inconsistency between choices and prices violates normative principles such as description invariance or transitivity, but it is necessary for them to accept that choices and prices should be consistent, and to detect and eliminate any inconsistencies.

Situations in which accountability amplifies response tendencies. Finally, there are few situations in which more extensive analytical thinking on the part of accountable participants actually increases tendencies toward the initially preferred response. Such increases may occur because participants believe that the reasons supporting the initially preferred response are valid, or at least defensible. Amplification has been observed for the following initial tendencies: (a) preferring an option with well-defined probabilities over an equally risky option with vague probabilities (*ambiguity aversion*); (b) when choosing between two options that do not dominate each other, preferring the one that dominates a third option (the *attraction effect*); (c) preferring options that are average on several dimensions over options that are good on some dimensions and bad on others; (d) preferring options that do not involve the possibility of a loss (loss aversion); and (e) weighting all information, regardless of its relevance or diagnosticity.

For the first three cases, and perhaps for the fourth, evidence suggests that the preferred option is perceived as easier to justify than the alternatives. In the fifth case, participants' indiscriminate use of information may result in part from a conversational norm in which the experimenter is assumed to supply only useful information. Results are mixed regarding whether the use of stereotypes or categorical information is attenuated or amplified by accountability.

Summary of accountability research. Taken together, these results are remarkably consistent with the dual-process theories presented earlier. Initial tendencies are largely based on the more intuitive association-based System 1. When respondents are motivated to process information more analytically, the shift from System 1 to System 2 leads to a very sensible pattern of results. When additional analytical thought reveals additional useful information or steers respondents to better problem-solving strategies, the initial "biased" response tendencies are attenuated. However, when analytical processing fails to uncover better strategies because respondents do not posses the needed knowledge or abilities, their initial response tendencies are unchanged. Finally, additional analytical processing can amplify initial response tendencies when respondents view those tendencies as logical or justifiable, and can also degrade performance when respondents' attempts to be comprehensive lead them to use irrelevant information.

Whether these results may be generalized to analytic-deliberative processes depends in large part on whether those situations entail *predecisional* accountability to an audience with *unknown views* who is interested in good decision *processes* more rather than particular decision outcomes. It seems very likely that accountability (if present) will be predecisional. The views of the primary audience (often a sponsoring agency or political figure) may be known ahead of time, but there are many instances in which the best solution may not be known to anyone prior to the analytic-deliberative process. In such situations, accountability may be based predominantly on process issues. Of course, participants in such processes may also be accountable to the organizations or constituencies that they represent.

Summary

The results presented in the debiasing and accountability sections above are broadly consistent with each other and with dual-process theories of information processing in judgment and decision-making tasks. Shifting from an intuitive to an analytical approach usually reduces the initial response tendency ("bias"), but interventions may have no effect if greater analytical effort fails to identify better problem-solving strategies or leads respondents to consider useless information. Interventions may backfire if generating additional alternatives or reasons for making different predictions is difficult, or if the initially preferred option is viewed as more justifiable than the alternatives. These results, along with positive results for specific training and feedback interventions, suggest that more formal decision aids are potentially useful. Such aids might help people to consider all of the relevant alternatives, utilize information about these alternatives consistently, and integrate complex information in a normatively defensible manner. North and Renn discuss several types of decision aids in an accompanying chapter for the public participation committee.

Some Lessons for Risk Managers and Risk Communicators

The rich scientific literatures in human judgment and decision making not only suggest ways that stakeholders and non-governmental groups can improve problem-solving strategies and deliberation about environmental problems, but also suggest ways for experts and regulators to improve the analytic-deliberative process. Since the 1970's, environmental policymaking in

the United States has become more responsive to public values and perspectives. Efforts by regulatory agencies to engage stakeholders in the policy process in meaningful and substantive ways have increased significantly (Beierle & Konisky, 2000; VanNijnatten, 1999). Public participation models have evolved from merely informing the public or full disclosure to active engagement of communities in the process of decision-making (Rowe & Frewer, 2000; VanNijnatten, 1999). The success of these efforts depends on the design of reasonable analytic-deliberative processes that acknowledge and incorporate the judgment and reasoning predispositions of the public. An exclusion of public values, perspectives and concerns when formulating a participatory approach to decision-making increases the likelihood of a confrontational and adversarial process (e.g., EPA, 1992; NRC, 1996; Sandman, 1995). Thus, risk managers must be sensitive to the framing of problems and reasoning strategies adopted by involved parties, and present information in ways that are compatible with these. This suggests, for example, that for some populations, complex risk information may need to be presented in multiple ways, including more narrative formats to facilitate assimilation of relevant facts given System 1 and System 2 approaches to information processing and reasoning (e.g., Kahlor, Dunwoody & Griffin, 2003). However, the goal of analytic-deliberative processes should not be to persuade the public to agree with experts' reasoning about and structuring of risk or environmental problems, but rather to cast decision-making in ways that promote an integration of technical expertise and, "…a wide range of public interests, ideas, questions and concerns." (Futrell, 2003, p. 454). Although more intuitive and experiential modes of reasoning (System 1) may be more common among public groups and community members than experts or regulators, these approaches to problem-solving and decision-making are not necessarily biases and errors that need repairing (e.g., Epstein et al., 1996; Stanovich & West, 2000). For example, alternative ways of structuring or reasoning about an environmental or risk problem may lead to new questions and priorities regarding an exposure situation, and improve the technical representation of risk and options (e.g., Futrell, 2003). The System 1 mode of reasoning (i.e., the more intuitive, affect-based system) contextualizes decision problems, bringing to bear prior beliefs that may provide important information for future decisions and judgments (Stanovich & West, 2000). Decontexualizing risk or environmental problems from the social, political, historical and cultural contexts in which events occur may not be the most adaptive strategy for environmental problem solving. In some cases, this reasoning approach may lead to assessments that ignore relevant information such as simultaneous multiple exposures or vulnerabilities of special populations (e.g., Futrell, 2003; Petts, 2004).

Knowledge of psychological processes that affect how people think about and judge environmental and risk problems may be useful for reducing those biases that inadvertently obscure public preferences, priorities and interests during a participatory process. However, some differences in problem framing, reasoning strategies, risk perceptions are likely to remain even with desirable decision aids. Whether these represent barriers to participation and deliberation depends upon other factors such as if organizational culture and fragmentary decision processes weaken the integration of analysis and deliberation at crucial stages of the process (Petts, 2004). Additionally, it is worth noting that experts and representatives of regulatory agencies may be vulnerable to some of the same "errors and biases" that are usually discussed relative to the general public (e.g., Petts, 2004), and decision aids targeting these parties may also improve the analytic-deliberative process.

Conclusion

The psychological sciences offer considerable insights into how various individual stakeholders may arrive at specific judgments, perceptions and decisions during an analytic-deliberative process. This knowledge can be used to overcome some of the technical and practical barriers to participation and deliberation in risk or environmental decisions (Petts, 2004). An exclusion of public values, perceptions and concerns in a process of formulating a decision or policy increases the likelihood of a confrontational and adversarial process (e.g., EPA, 1992; NRC, 1996; Sandman, 1995). If public involvement is to be substantive and early in the process in order to achieve desirable goals (e.g., Burke, 1995; Fisher, 1992; Kaminstein, 1996; Renn et al., 1995; Sandman, 1995; Webler & Tuler, 1999), then risk managers must be prepared for the alternative ways of thinking and deliberating about environmental problems that are likely to be encountered. An effective analytic-deliberative process facilitates and supports decision-making at the level of the individual, and accommodates the variety of strategies that interested parties bring to the table to structure problems, evaluate options and make decisions during problem solving. The evidence presented in this chapter also implies that activities at certain stages of an analytic-deliberative process will especially benefit from being informed by scientific findings on individual-level judgment and decision-making (e.g., when the technical representation of a risk problem is the topic of deliberation) (Futrell, 2004; Petts, 2004). Applying knowledge from the science of individual judgment and decision-making to participatory processes undoubtedly will need to overcome some institutional barriers and organizational culture. Certain existing orientations may, in some instances, be incompatible with integrating the public's conceptualization of problems and approaches to problem solving in the decision process (Petts, 2004). Although the information summarized in this chapter suggests ways to improve deliberation and the analytic-deliberative process, small group dynamics and broader social, organization and political forces also have significant impacts on the effectiveness of collaborative approaches to environmental assessment and decision-making.

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