15

Group Report: Effects of Emotions and Social Processes on Bounded Rationality

Barbara A. Mellers, Rapporteur
Ido Erev, Daniel M.T. Fessler, Charlotte K. Hemelrijk,
Ralph Hertwig, Kevin N. Laland, Klaus R. Scherer,
Thomas D. Seeley, Reinhard Selten, and Philip E. Tetlock

INTRODUCTION

People facing decisions are constrained by computational capacities of the human mind, i.e., they are limited in their perceptions, their attention, their memories, as well as their information-processing abilities. Rather than optimizing, they resort to simplifying rules and heuristics. Gigerenzer et al. (1999) explore fast and frugal heuristics and argue that these tools work remarkably well because they exploit structural regularities in the environment. The heuristics they discuss are largely based on cognitive processes. In this chapter, we discuss heuristics that exploit structure in the social and emotional world.

EMOTIONAL PROCESSES IN THE ADAPTIVE TOOLBOX

Emotions have traditionally been regarded as impediments to rationality. They wreak havoc on orderly thought, interfere with logical reasoning, and subvert the most carefully laid plans. In the past, emotions have been linked to madness; the Romans, for example, treated anger as a temporary bout of insanity (de Sousa 1987). Although emotions can be detrimental, we focus here on their adaptive properties.

Darwin (1872) was one of the first to make the case that emotional expressions are beneficial. Threatened animals often show their teeth and, in the process, signal their ability, and perhaps their intention, to attack an aggressor. People who are surprised open their eyes widely and, in that way, obtain as much new information as possible. These expressions have evolved to provide advantages to survival and reproduction.

More recently, Damasio (1994) demonstrated the importance of emotions by examining what happens to those who cannot experience them. He describes a patient named Elliot who suffered from a particular form of frontal lobe damage. Although Elliot's reasoning processes were excellent, he was unable to experience feelings. The absence of emotions was disruptive enough to render him incapable of functioning as a social being.

Damasio argues that Elliot is a modern-day version of Phineas Gage. Gage worked for the railroad and often set off explosives to clear away rocks and debris. On a fateful day in 1848, an accident occurred. An iron rod pierced his cheek, came out through the top of his skull, and damaged his frontal lobe in the same region as that of Elliot. Gage survived the accident and, miraculously, retained his capacity for rational thought. However, his personality was different: he was unable to experience emotions. Damasio argues that Gage's tragic decline and eventual death were caused by his inability to experience emotions and behave appropriately as a social being.

Emotions have beneficial effects from the first day of life. Infants typically smile in their first or second day and laugh in their fourth or fifth month. Smiling, laughing, and crying increase the infant's chances of obtaining parental attention (Freedman et al. 1967). By the eighth month, infants smile selectively in response to familiar faces and cry in response to unfamiliar ones. Such smiles further reinforce attachments between parent and child.

Later in life, emotions serve a wider array of functions. Damasio (1994) suggests that, when considering the consequences of our actions, we associate anticipated outcomes with bodily feelings. For example, bad outcomes are linked to unpleasant gut reactions. Those visceral feelings can direct our attention away from decisions with unpleasant feelings and toward decisions with more pleasurable ones. Damasio refers to the process as the somatic marker hypothesis. This process, he claims, implicitly reduces the number of options we consider and makes our decisions more manageable.

Frank (1988) stresses the economic advantages of emotions. Emotions promote self-interest, not because of any hidden gains in their expression, but rather because they solve commitment problems. Some decisions require difficult-to-reverse commitments from individuals, even though the commitments may be contrary to their short-term interests. Consider a couple who wants to marry and have children. They may be reluctant to do so for fear of their partner leaving if and when a more attractive mate becomes available. The couple could solve the problem by writing a contract with large penalties on divorce, or they

could rely on the bonds of romantic love. Strong emotional commitments may be the best way for the couple to achieve their long-term goals.

Emotions also solve problems of social control. Feelings of guilt and shame keep most people from cheating, even when cheating serves their short-term interests. Furthermore, people recognize that if others perceive them as cheaters, they may be denied future opportunities. In this way, guilt and shame constrain behavior and provide strong social constraints on respectable members of a community.

In a similar vein, feelings of fairness can deter selfish behavior. The ultimatum game provides an example. In this game, two individuals are typically paired up, and one is given a fixed sum of money to divide between them. That individual makes an offer, and if the other accepts, the money is divided between them according to that offer. If the offer is rejected, both individuals receive nothing. Suppose a player has $10 to divide. The rational offer is to keep $9.99 for oneself and offer 1 cent to the other player. The rational response is to accept. In fact, many people often reject such offers and act angered by the unfairness of the offer. This "irrational" response conflicts with notions of self-interest, (i.e., a penny is better than nothing, isn't it?) when in fact, the response may protect that player from future injustices in games with repeated play. Would-be players tempted to offer sharply unequal allotments recognize the likelihood of the other player's anger and may be deterred from acting unfairly.

What Are Emotions?

Emotions are relatively brief episodes of synchronized responses that produce noticeable changes in the functioning of an organism. Such changes are brought about by triggering events of major significance (Scherer 1999). The term, "emotion," refers to a combination of components, including physiological arousal, motor expression, and subjective feelings with emotional and motivational consequences. Emotions usually last for a relatively short period of time and disappear fairly rapidly, generally ranging from several minutes to a few hours, with the exception of sadness. Other affective phenomena longer in duration include moods (e.g., cheerful, gloomy, irritable, listless, depressed, buoyant), interpersonal affective stances (e.g., distant, cold, warm, supportive, contemptuous), attitudes (e.g., liking, loving, hating, valuing, desiring), and affectively pertinent personality traits (nervous, anxious, reckless, morose, hostile, envious, jealous).

Most researchers agree on at least eight emotions, including anger, sadness, joy, fear, shame, pride, disgust, and guilt (Ekman 1992; Frijda 1986; Izard 1991). Others include surprise. There is still considerable debate about whether some emotions are "basic" in an evolutionary sense (Ortony and Turner 1990; Izard 1992). The specific effects of an emotion are not always obvious, so many researchers consider their adaptive functions within an evolutionary context

(Mesquita et al. 1997). Some emotions, such as disgust, have undoubtedly evolved to protect animals from toxins. After becoming sick from a particular food, animals are usually repulsed by the same food on another encounter. Taste aversion can occur after a single trial. Furthermore, the conditioned stimulus and the unconditioned stimulus need not occur together; animals still avoid the food, even with gaps of up to 75 minutes between food and sickness (Garcia and Koelling 1966). Taste aversion can also be culturally defined. A particular food may be a delicacy in one culture, but repulsive in another.

Fear is another emotion with evolutionary implications. Animals that are fearful are more likely to take flight and escape their predators. However, when they become too fearful, they miss opportunities for survival and reproduction. It has long been thought that fear was innate; for example, many primates who see a snake for the first time exhibit fearful reactions, including flight, facial expressions indicative of fear, visual monitoring of the snake, and alarm or distress calls. However, recent evidence suggests that fear also can be learned (Mineka and Cook 1988).

Three classes of theories have been offered to describe emotions: discrete, dimensional, and appraisal-based. Discrete theories, stemming from Darwin, postulate a number of basic emotions characterized by early ontogenetic onset and universal facial expressions. Dimensional theories, following Wundt's example, characterize emotions as values along one or more continua, such as pleasantness vs. unpleasantness, restfulness vs. activation, and relaxation vs. attention. The simplest version postulates a single dimension of negative and positive affect, fundamental to approach and avoidance tendencies. More complex versions have three or more dimensions. The third class of theories are appraisal-based approaches as pioneered by Arnold (1962) and Lazarus (1968). They assert that emotions are elicited by a cognitive, but not necessarily conscious or controlled, evaluation of antecedent conditions. For example, the component-process theory (Scherer 1984) predicts that the organism uses a limited number of evaluation checks on the stimulus (novelty, intrinsic pleasantness, goal conduciveness, coping potential, and comparability of standards) to monitor events in the environment. Emotions are part of this appraisal process. Anger is produced by an event appraised as interfering with goal attainment, fear is produced by expectations of future events that exceed one's potential for coping, and joy is produced by achievement of a goal.

Emotions and Bounded Rationality

Emotions facilitate rapid, automatic, and survival-oriented actions. Frijda (1986) argues that emotions serve as "relevance detectors," where relevance is determined by an individual's perceptions of a situation. Scherer (1984) emphasizes the role of emotions as replacements for reflexes, instincts, and simple stimulus-response chains that involve the automatic execution of a response. By

decoupling the stimulus and response, the organism has time to reevaluate the eliciting event and consider more than one behavioral response.

It is helpful to distinguish among three routes by which emotions can influence choice. We refer to these as background emotions, task-related emotions, and anticipated emotions. Background emotions are those that the decision maker experiences at the time of the choice, but are not elicited from the decision itself. Task-related emotions, such as frustration and anxiety, arise in the course of making a decision. Finally, anticipated emotions are those that the decision maker imagines about future courses of action. We now discuss each in turn.

Background Emotions

Everyone who has ever made a decision remembers occasions in which unrelated moods and emotions took charge. These background emotions also affect perceptions and memories. When happy, we are better at retrieving happier memories, and when sad, we are better at recalling unhappy events (Bower 1981). If memories are marked with somatic tags, background moods may facilitate retrieval of similarly tagged memories. Damasio (1994) notes that emotions direct perceptions to our bodies, and those visceral sensations send instructive signals for action.

Background emotions can also influence attention by focusing it on particular stimuli and influencing the search for information and alternatives. Positive emotions, such as satisfaction, joy, and pride, can shorten the search for alternative options, especially when the decision maker is satisfied with current achievements relative to an aspiration level. Conversely, mild forms of anxiety may foster a more intensive search for alternatives. Anger may focus the individual on actions that lead to revenge and bring the search for new alternatives to a standstill.

Last but not least, background emotions can influence the strategies or heuristics we use to process information. Some positive emotions can promote more flexible and creative problem solving (Isen 1993), and some negative emotions, such as sadness, can lead to more analytical thinking, greater processing of cues, and longer response times (Luce et al. 1997; Luce 1998). Both positive and negative emotions vary in strength or arousal, and psychologists have shown that task performance and arousal are often nonlinearly related, i.e., task performance is best when arousal is moderate.

Task-related Emotions

Some decisions create conflict. We are uncertain about what to do because no single option clearly dominates all others. Bettman et al. (1993) and Einhorn and Hogarth (1981) have operationalized decision conflict as the degree to which valued attributes are negatively correlated. For example, professors making selection decisions for graduate school often find that applicants have either high

test scores or high grades, but not both. Families purchasing houses often find that they must face difficult trade- offs, such as whether to have more space in their home or a shorter commute time.

When there is no single best option, people look for reasons to justify their choices (Tversky and Shafir 1992a). People may also prolong the search and/or delay the decision (Tversky and Shafir 1992b; Dhar 1997). Luce (1998) has found that, when consumers experience decision conflict about which product to purchase, they often process more information, but then use simpler decision heuristics that permit them to avoid emotionally difficult trade-offs.

One strategy that people appear to use when making difficult trade-offs is to weight the most important attribute more heavily (Tversky et al.1988). Another strategy is to use simple rules of thumb based on emotions. Hsee (1995, 1996) has shown that, as the difficulty of a choice increases, people tend to select their affectively preferred options more frequently.

Many important decisions are made under severe time pressure. Janis and Mann (1977) discuss the feelings of extreme ambivalence and stress that individuals feel in military, political, and economic domains. They also identify some common maladaptive coping patterns that people adopt, such as defensive avoidance, panic, and hypervigilance. When groups make decisions, additional problems can occur. Conformity pressures can increase and produce "group think," in which group members suppress their doubts about a plan of action and fail to explore the subtleties and complexities that should be discussed.

Tetlock et al. (1996) have examined how people make decisions requiring difficult trade-offs between core values, such as money and love. In these cases, decision makers lack a common metric for comparing values. This problem, sometimes called "value incommensurability" contributes to emotional conflict, cognitive dissonance, and social awkwardness. In other cases, decisions involve transgressions of personal and cultural taboos that are even more severely charged with affect and symbolism. Such trade-offs are sometimes called "constitutively incommensurable." They are not just cognitively dissonant, they are also morally corrosive in the sense that the longer we spend thinking about proposals that breach cultural limits on markets — proposals to auction off body organs to medically needy recipients or to permit the buying and selling of adoption rights for children — the more we undercut our identities as members in good standing in a moral community. The anger and indignation that people feel upon being asked such questions, and the anger they know observers feel at those willing to entertain such proposals, serve as a warning signal to pursue this line of thought no further.

Anticipated Emotions

Decisions are often made with the help of a process of imagination in which we try to experience outcomes "before the fact." Anticipated feelings, such as guilt,

shame, fear, and joy, are ways of testing ourselves to see how we feel about possible outcomes. A variety of anticipated emotions have been studied, especially anticipated regret (Landman 1993). Anticipated regret of a new product that malfunctions can increase the chances that people will buy a familiar product (Simonson 1992). Anticipated regret of a child becoming ill or dying from a vaccination increase the chances that people will not vaccinate their children (Ritov and Baron 1990). Anticipated regret of losing a lottery increases the chances that students will refuse to trade their original lottery tickets for new lottery tickets with objectively better odds (Bar-Hillel and Neter 1996). Finally, anticipated regret of a new medical procedure failing increases the chance that physicians will take the safer, more familiar route when treating a patient.

The anticipation of emotions may involve cognitive processing, consistent with appraisal-based theories, or more visceral processing, as suggested by Damasio's somatic marker hypothesis. Results from studies that ask participants to imagine fearful stimuli suggest that the mere thought of extreme negative experiences can activate fearful facial expressions, heart rate, and respiration (Schwartz et al. 1976; Lang et al. 1980). Most likely, both cognitive and emotional processes are involved. Cognitive processing seems plausible with milder emotions, and more visceral processes may dominate with extreme emotions (Le Doux 1996).

Some efforts have been made to formalize the process by which anticipated emotions influence choice. Loomes and Sugden (1982) and Bell (1982) proposed an account of risky choice based on anticipated regret. Regret is the feeling that occurs when one's outcome is worse than the other outcome that would have occurred under another choice. According to regret theory, people anticipate regret and modify their utilities to reflect it. Then they select the option with the greater expected utility, modified by anticipated regret. Later, Loomes and Sugden (1986) and Bell (1985) developed another account of risky choice called disappointment theory. Disappointment is the feeling that occurs when one's outcome is worse than the outcome one would have received under another state of the world.

Both regret theory and disappointment theory have been successful at describing some aspects of risky choice, but the assumptions about emotions were never tested directly. Mellers et al. (1997, 1999) measured anticipated emotions and then obtained risky choices. They developed a theory of anticipated affect and used it to describe risky choice. Their account, called subjective expected pleasure, expands upon disappointment and regret theories by assuming that people anticipate how they will feel about all outcomes of a decision, weight each anticipated emotion by the chances it will occur, and select the option that provides the greater average pleasure. This account gives a good description of risky choices between gambles with monetary outcomes.

With some decisions, such as whether to move, take a new job, have a child, or get married, it is impossible to anticipate all possible outcomes. With other

decisions, one may not be interested in more than a few possible outcomes. Feelings about those outcomes can be strong enough that we simply avoid an alternative with a potentially severe consequence. Some people avoid California for fear of earthquakes, some avoid alcohol for fear of getting addicted, and some avoid the stock market for fear of financial disaster.

Avoiding pain is not the only emotional basis for decisions. In other instances, people pursue pleasure. Teenagers who race cars at high speeds, take dangerous drugs, and engage in unsafe sex may be so immersed in momentary pleasure that they disregard the possibility of future pain and suffering. Loewenstein (1996) discusses a variety of cases in which people make decisions, but are essentially "out of control," including those with addictions and cravings. Simple emotion-based heuristics can be both adaptive and maladaptive, depending on the context and the consequences.

SOCIAL PROCESSES IN THE ADAPTIVE TOOLBOX

We live in social networks, adopt social norms, feel social pressures, and make social comparisons. In this section, we discuss three ways in which social processes influence decision making. First, we discuss the social context that shapes our decisions. Then we discuss fast and frugal heuristics based on social processes.

The Social Context

The mere presence of others influences our behavior. Zajonc (1965) argued that the social context is arousing, and arousal facilitates dominant responses. That is, it boosts performance on easy tasks and hinders performance on harder tasks. For example, ants excavate more sand in the presence of other ants, and chickens eat more grain in the presence of other chickens (Bayer 1929; Chen 1937). A large body of research shows that people tended to perform better on relatively simple tasks, such as easy multiplication problems. However, their performance is hindered by the presence of other people with more difficult tasks. They are slower at learning mazes, nonsense syllables, and complex multiplication problems in the presence of other people. Cockroaches, parakeets, and green finches also learn mazes more slowly in the presence of others (Allee and Masure 1936; Gates and Allee 1933; Klopfer 1958).

The presence of others can do more than facilitate dominant responses. It can also increase social loafing; individuals working in groups do not work as hard as individuals working alone (Latane et al. 1979). It can interfere with automatic responses, such as speaking. Stutterers stutter more in front of others (Mullen 1986). It can intensify emotions (Storms and Thomas 1977). People who sit close to each other in a room behave different from people who sit far apart. When sitting together, people are more likely to laugh and clap at amusing

stimuli (Freedman et al. 1980). They are also more likely to express anger and outrage at stimuli perceived as unfair and unjust. Finally, the presence of others can increase conformity. Asch (1956) was one of the first to demonstrate the powerful effects people can have on each other. He asked students in a room to judge the length of a line relative to a standard. Students seated around a table gave their answers, one after the next. Asch manipulated the number of students who gave the incorrect answer before a naive subject was asked the question. Naive subjects were more likely to give incorrect responses, even when they knew their answers were wrong, as the number of wrong answers given before them increased.

Social networks have powerful effects on decisions, especially those regarding interpersonal relationships. One of the best predictors of friendship is proximity in living quarters. Festinger et al. (1950) observed the friendships in MIT married student apartments. Couples were assigned to apartments at random, but the friendships that developed were anything but random. When asked to name their three closest friends, students in the apartments tended to name others living in the same building or on the same floor. The individual chosen most often was the person living next door.

Finally, social norms and social expectations influence choice. Individuals who accept a role, such as a parent, a dentist, an accountant, or a secretary, also tend to accept a set of rules that prescribes their behavior. Doctors in hospitals, professors in classrooms, and workers on assembly lines adopt heuristics for decisions as part of their identities. These social norms often free people from evaluating the appropriateness of their behavior and permit them to direct their attention to other matters (March 1994).

Many social norms are so subtle that they often go unnoticed. Consider the norm of cleanliness in a particular environment. Such norms are quickly altered by the behavior of others in that environment. Cialdini et al. (1990) showed that people tended to litter more when a given environment was already littered than when it was clean. Rule violators are often punished, and punishments can range from embarrassment to execution. Tolerance of rule violators also differs across cultures and is a type of social norm.

Social Learning

Bismarck is reputed to have once said, "Fools learn from experience; wise men learn from the experience of others." Animals facing problems such as finding food, avoiding predators, and selecting mates often turn to each other for solutions. Laland (this volume) notes that social learning has many forms, each reflecting the nature of what is learned (motor patterns, locations, objects to interact with, goals, etc.). When animals imitate, they learn by copying the motor patterns of another animal in a particular context. With local enhancement, animals learn by directing their attention to the same object as another animal.

Imitation and local enhancement are useful heuristics, but they both require further decisions. To imitate, one must decide who to imitate as well as what and when to imitate. Strategies such as "do-what-the-majority-do" or "do-what-the-successful-do" are plausible rules. Animals would presumably use such heuristics when there were high costs associated with asocial learning, frequent variation in the environment, and few opportunities for scrounging (or stealing) (Boyd and Richerson 1985; Giraldeau et al. 1994). Social learning may also be advantageous when competition for resources is relatively light or when animals band together in unfamiliar or threatening environments. Asocial strategies may be desirable for less successful animals. Laland believes that less successful animals may be those most likely to try innovative strategies. These animals may try imitation, but if that fails, they resort to innovative heuristics.

Imitation is also a successful heuristic with humans, especially with social dilemmas. Social dilemmas are situations in which people who pursue their self-interests eventually make the group worse off. The prisoner's dilemma game is a well-known example of such a problem. In prisoner's dilemma games with repeated play, one strategy seems to outperform all others. This strategy, called Tit-for-Tat, is one in which a player cooperates on the first trial and then imitates the other player on all remaining trials. Axelrod (1984) has shown that Tit-for-Tat outperforms all other strategies in computer tournaments. He attributes its success to four key functional properties: one who adopts the Tit-for-Tat strategy is nice (never defects first), cooperative (always reciprocates cooperation), forgiving (returns to cooperation as soon as the other player does), and retaliatory (strikes back as soon as the other player defects).

Group Decision Making

Individuals often meet to solve problems through give-and-take interactions. Which heuristics facilitate group decisions? One rule is called the Delphi method. This rule dates back to sometime around 250 B.C., when King Ptolemy decided to translate some biblical writings into Greek. The king asked the high priest of Judea to help. The priest selected seventy scholars, sent them to Alexandria, put each in a separate room, and asked each to do his translation independently. When the job was done, a committee that examined the seventy translations found that they were identical. Word spread, and everyone was astonished. But when an old Rabbi heard what had happened, he said, "Seventy scholars in separate rooms, and this you call a miracle? Put them in one room and get the same translation — this is a miracle."

The translation story illustrates the idea behind the Delphi method, a procedure for group decision making in which individuals give separate opinions, receive information about the views of others, give their separate opinions again, and eventually converge on a decision without face-to-face confrontations. This simple heuristic has proven to be an effective strategy for reaching agreement using impersonal debate (Dalkey 1975; Dalkey and Helmer 1963).

The natural competitor to the Delphi method is free-form discussion. Other more mathematical rules have also been proposed for aggregating individual judgments. The Delphi method exploits the idea that individuals come with different forms of expertise, different knowledge bases, and different biases, all of which should enter into a consensus decision. More recently, Delbecq et al. (1975) proposed an alternative in which individuals make silent judgments, learn the judgments of the group, discuss the problem, and then reconsider their judgments individually. Final judgments are aggregated mathematically. This procedure has also shown promise and some have argued that it can improve on the Delphi method (Gustafson et al. 1973).

EXPLORING HEURISTICS BASED ON EMOTIONS AND SOCIAL PROCESSES

Mate choice is an important decision based on social and emotional processes. Buss (1989) describes rules used in mate choice among humans. He argues that selection pressures have influenced human mate preferences in systematic ways. Male reproductive success depends on mating with females who are fertile, and fertility is correlated with youth and beauty. Female reproductive success depends on finding males who show the ability and willingness to invest resources in their offspring. Buss (1989; Buss et al. 1990) investigates mate preferences cross-culturally and finds that males placed greater value than females on relative youth and physical attractiveness in potential mates. Females placed greater value than males on earning capacity and variables related to resource acquisition in potential mates. He attributes these preferences, which presumably guide mate selection, to adaptive pressures over time.

In any real world setting, there are multiple explanations for mate choice. For example, ethologists have described two types of primate species belonging to the genus *Macaca*: "despotic" (e.g., rhesus macaques, *Macaca mulatta*) and "egalitarian" (e.g., Sulawesi macaques, *Macaca tonkeana*) species. Despotic macaques have a steep dominance hierarchy, loose grouping, and fierce displays of aggression that are relatively rare. Egalitarian macaques have a weak dominance hierarchy, cohesive grouping, and mild aggressive tendencies that occur quite frequently. Females in the two types of species display different types of mating behavior. Females in the despotic species select only high-ranking males, whereas those in the egalitarian species are highly promiscuous. What accounts for this difference in mate choice?

Some have argued that females in each type of species have different rules for mate choice (Caldecott 1986). By means of an individual-oriented computer model, Hemelrijk (1999) proposed, as an alternative explanation, that females differ in their opportunities for mating rather than their heuristics for choosing. Opportunities for mating are implicit constraints. Hemelrijk's model asserts that individuals within each sex have identical dominance ranks, although males are

more dominant than females. Individuals in both types of species aggregate and perform interactions that eventually produce a dominance hierarchy.

The two virtual species are identical with one exception — the intensity of their aggression. Despotic species are more aggressive, an assumption consistent with observations of real macaques. According to the model, in the despotic species, competitive interactions result in a steep dominance hierarchy, and a clear spatial structure emerges, with high-ranking individuals in the central area and subordinates in the periphery. In the egalitarian species, both the dominance hierarchy and the spatial structure are much weaker. Now something peculiar starts to happen.

Hemelrijk predicts that, in the egalitarian species, males will maintain higher ranks and females will keep their lower ranks. In the despotic species, there is stronger differentiation. Consequently, some females become more dominant than males. This intersexual overlap in ranks is likely to influence sexual behavior. For instance, Rosenblum and Nader (1971) showed that, with Bonnet macaques, males with lower rankings are often inhibited with higher-ranking females. Hemelrijk (1999) argues that if a similar inhibition took place with despotic males, despotic females, because of their higher ranks, would have fewer mating partners than egalitarian females, holding all else constant. In Hemelrijk's model, if intersexual rank overlap is larger in despotic macaques, despotic females show selective mate choice because the number of mates available to them is limited. Females in the egalitarian species not only have more partners, they are also less capable of refusing their partners because of their subordinate ranks relative to males. Whether or not there are real differences in female mate choice remains to be seen.

Hertwig proposed an exercise in computer simulation to examine the effects of romantic love in mate search (see also Miller and Todd 1998). Consider a population that is comprised of female and male agents, each characterized by several cues. Female agents are described in terms of their reproductive potential, and male agents are described in terms of their ability to acquire resources and invest them in offspring (Buss 1992). Each agent has an aspiration level that must be met before an agent accepts a partner. This aspiration level could be acquired via individual learning (e.g., feedback concerning one's own mate quality) or social learning (e.g., imitating peers, that is, adopting the aspiration level of proximal agents). Furthermore, aspiration levels of females are higher than those of males. An agent combines cues to assess another agent's mate value, for example, using a weighted additive rule (see Payne and Bettman, this volume). Then the agent compares the overall mate value to his or her aspiration level, and if the overall assessment exceeds the aspiration level, the potential mate would be accepted. Furthermore, if a "good" match occurs, romantic love might be evoked in one or both of the individuals.

Hertwig identifies three potential functions of romantic love. First, an expression of romantic love will increase an agent's mate value in the eyes of the

recipient. Second, romantic love will change the agent's perceptions of the loved one (i.e., increase cues values or importance weights on favorable attributes), thereby strengthening the bond. Third, an agent who expresses romantic love will stop his or her search for a mate, at least for some time. In this sense, romantic love becomes a commitment device, as described by Frank (1988).

By examining these functions, one can gain insight into the effects of romantic love on population size, number of matings, number of offspring, and other variables. One can also investigate the conditions under which romantic love would be advantageous to selected groups within the population, such as males, females, or agents with lower mate values. These exercises help us understand plausible functions of romantic love in different environments and their effects on population survival.

CONCLUSION

Models of bounded rationality are based on assumptions about limited time, resources, and mental capacities. Because of these limitations, people often rely on simple rules that exploit the structure in the environment. Fast and frugal heuristics proposed thus far have focused on cognitive strategies. We have examined heuristics based on emotions and social processes.

Emotions can influence all aspects of decision making. We discussed background emotions, task-related emotions, and anticipated emotions. Background emotions are those that the decision maker experiences at the time of the choice, but are not elicited from the task itself. Task-related emotions, such as frustration and anxiety, arise in the course of making a decision. Finally, anticipated emotions are those that the decision maker imagines about future courses of action. In some cases, choices can be predicted by a Which-Feels-The-Best? heuristic. In other cases, people may use more complex heuristics, such as a Which-Feels-Best-On-Average? heuristic.

Many decisions can be solved by more than one fast and frugal rule and, over time, decision makers learn which heuristics work. Emotions are an important part of the learning process. When the consequence is rewarding, feelings are pleasurable, and when the consequence is punishing, feelings are painful. In this way, emotions serve as secondary reinforcers to learning.

Social processes also influence fast and frugal heuristics. We live in social networks, adopt social norms, feel social pressures, and make social comparisons. We discuss the social context or background factors that shape our decisions. Then we discuss social heuristics for individual and group decision making.

Finally, we examine the use of fast and frugal heuristics in mate choice and show how both empirical work and computer simulations can shed light on underlying processes and functions of emotions. We eagerly await future research on fast and frugal heuristics that exploits additional structure in our social and emotional worlds.

REFERENCES

Allee, W.C., and R.M. Masure. 1936. A comparison of maze behavior in paired and isolated shell-parakeets (*Melopsittacus undulatus Shaw)* in a two-alley problem box. *J. Comp. Psych.* **22**:131–155.

Arnold, M.B. 1962. Emotion and Personality, vol. 1: Psychological Aspects. New York: Columbia Univ. Press.

Asch, S.E. 1956. Studies of independence and conformity: A minority of one against a unanimous majority. *Psych. Mono.* **70 (9, No. 416).**

Axelrod, R. 1984. The Evolution of Cooperation. New York: Basic.

Bar-Hillel, M., and E. Neter. 1996. Why are people reluctant to exchange lottery tickets? *J. Pers. Soc. Psych.* **70**:17–27.

Bayer, E. 1929. Beiträge zur Zweikomponenten Theorie des Hungers. *Z. Psych.* **112**:1–54.

Bell, D.E. 1982. Regret in decision making under uncertainty. *Operations Res.* **30**:961–981.

Bell, D.E. 1985. Disappointment in decision making under uncertainty. *Operations Res.* **33**:1–27.

Bettman, J., E.J. Johnson, M.F. Luce, and J.W. Payne. 1993. Correlation, conflict, and choice. *J. Exp. Psych.: Learn. Mem. Cogn.* **19**:931–951.

Bower, G.H. 1981. Mood and memory. *Am. Psych.* **36**:129–148.

Boyd, R., and P.J. Richerson. 1985. Culture and the Evolutionary Process. Chicago: Univ. of Chicago Press.

Buss, D.M. 1989. Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behav. Brain Sci.* **12**:1–49.

Buss, D.M. 1992. Mate preference mechanisms: Consequences for partner choice and intrasexual competition. In: The Adapted Mind, ed. J.H. Bakow, L. Cosmides, and J. Tooby. New York: Oxford Univ. Press.

Buss, D.M., et al. 1990. International preferences in selecting mates. *J. Cross Cult. Psych.* **21**:5–47.

Caldecott, J.O. 1986. Mating patterns, socieities, and ecogeography of macaques. *Anim. Behav.* **34**:208–220.

Chen, S.C. 1937. Social modification of the activity of ants in nest-building. *Physio. Zool.* **10**:420–436.

Cialdini, R.B., R.R. Reno, and C.A. Kallgren. 1990. A focus theory of normative conduct. *J. Pers. Soc. Psych.* **6**:1015–1026.

Dalkey, N.C. 1975. Toward a theory of group estimation. In: The Delphi Method: Techniques and Applications, ed. H.A. Linstone and M. Turoff, pp. 236–261. Reading, MA: Addison-Wesley.

Dalkey, N.C., and O. Helmer. 1963. An experimental application of the Delphi method to the use of experts. *Manag. Sci.* **3**:458.

Damasio, A. 1994. Descartes' Error. New York: Grosset/Putnam.

Darwin, C. 1872. The Expression of the Emotions in Man and Animals. New York: New York Philosophical Library.

Delbecq, A., A. Van de Ven, and D. Gustafson. 1975. Group Techniques for Program Planning. Glenview, IL: Scott Foresman.

de Sousa, R. 1987. The Rationality of Emotions. Cambridge, MA: MIT Univ. Press.

Dhar, R. 1997. Consumer preference for a no-choice option. *J. Consumer Res.* **24**: 215–231.

Einhorn, H.J., and R.M. Hogarth. 1981. Behavior decision theory: Processes of judgment and choice. *Ann. Rev. Psych.* **32**:53–88.

Ekman, P. 1992. An argument for basic emotions. *Cogn. Emot.* **6**:169–200.

Festinger, L., S. Schachter, and K. Back. 1950. Social Pressures in Informal Groups: A Study of Human Factors in Housing. New York: Harper.

Frank, R. 1988. Passions within Reason. New York: Norton.

Freedman, J.L., J. Birsky, and A. Cavoukian. 1980. Environmental determinants of behavioral contagion. *Basic Appl. Soc. Psych.* **1**:155–161.

Freedman, D.G., C.B. Loring, and R.M. Martin. 1967. Emotional behavior and personality development. In: Infancy and Early Childhood, ed. Y. Brackbill. New York: Free Press.

Frijda, N.H. 1986. The Emotions. Cambridge: Cambridge Univ. Press.

Garcia, J., and R. Koelling. 1966. Relation of cue to consequence in aviodance learning. *Psych. Sci.* **4**:123–124.

Gates, M.F., and W.C. Allee. 1933. Conditioned behavior of isolated and grouped cockroaches on a simple maze. *J. Comp. Psych.* **15**:331–358.

Gigerenzer, G., P.M. Todd, and the ABC Group. 1999. Simple Heuristics That Make Us Smart. New York: Oxford Univ. Press.

Giraldeau, L.A., T. Caraco, and T.J. Valone. 1994. Social foraging: Individual learning and cultural transmission of innovations. *Behav. Ecol.* **5(1)**:35–43.

Gustafson, R.U., D.H. Shukla, A. Delbecq, and G.W. Walster. 1973. A comparative study of differences in subjective likelihood estimates made by individuals, interacting groups, Delphi groups, and nominal groups. *Org. Behav. Human Decis. Proc.* **9**:280–291.

Hemelrijk, C.K. 1999. An individual-oriented model of the emergence of egalitarian and despotic societies. *Proc. Roy. Soc. Lond. B* **266**:361–369.

Hsee, C.K. 1995. Elastic justification: How tempting but task-irrelevant factors influence decisions. *Org. Behav. Human Decis. Proc.* **62**:330–337.

Hsee, C.K. 1996. Elastic justification: How unjustifiable factors influence judgments. *Org. Behav. Human Decis. Proc.* **66**:122–129.

Isen, A.M. 1993. Positive affect in decision making. In: Handbook of Emotions, ed. M. Lewis and J.M. Haviland. New York: Guilford.

Izard, C.E. 1991. The Psychology of Emotions. New York: Plenum.

Izard, C.E. 1992. Basic emotions, relations among emotions, and emotion–cognition relations. *Psych. Rev.* **99**:561–565.

Janis, I.L., and L. Mann. 1977. Decision making: A psychological analysis of conflict, choice, and commitment. New York: Free Press.

Klopfer, P.M. 1958. Influence of social interaction on learning rates. *Science* **128**:903–904.

Landman, J. 1993. Regret. New York: Oxford Univ. Press.

Lang, P.J., M.J. Kozak, G.A. Miller, D.N. Levin, and A. McLean. 1980. Emotional imagery: Conceptual structure and pattern of somato-visceral response. *Psychophysiology* **17**:179–192.

Latane, B., K. Williams, and S. Harkins 1979. Many hands make light the work: The causes and consequences of social loafing. *J. Pers. Soc. Psych.* **37**:822–832.

Lazarus, R.S. 1968. Emotions and adaptation: Conceptual and empirical relations. In: Nebraska Symp. on Motivation, vol. 16, ed. W.J. Arnold, pp. 175–270. Lincoln, NE: Univ. of Nebraska Press.

Le Doux, J.E. 1996. The Emotional Brain. New York: Simon and Schuster.

Loewenstein, G. 1996. Out of control: Visceral influences on behavior. *Org. Behav. Human Decis. Proc.* **65**:272–292.

Loomes, G., and R. Sugden. 1982. Regret theory: An alternative of rational choice under uncertainty. *Econ. J.* **92**:805–824.

Loomes, G., and R. Sugden. 1986. Disappointment and dynamic consistency in choice under conflict. *Rev. Econ. Stud.* **53**:271–282.

Luce, M.F. 1998. Choosing to avoid: Coping with negatively emotion-laden consumer decisions. *J. Consumer Res.* **24**:409–433.

Luce, M.F., J. Bettman, and J. Payne. 1997. Choice processing in emotionally difficult decisions. *J. Exp. Psych.: Learn. Mem. Cogn.* **23**:384–405.

March, J.G. 1994. A Primer of Decision Making. New York: Free Press.

Mellers, B.A., A. Schwartz, K. Ho, and I. Ritov. 1997. Decision affect theory: Emotional reactions to the outcomes of risky options. *Psych. Sci.* **8**:423–429.

Mellers, B.A., A. Schwartz, and I. Ritov. 1999. Emotion-based choice. *J. Exp. Psych.: Gen.* **128**:332–345.

Mesquita, B., N.H. Frijda, and K.R. Scherer. 1997. Culture and emotion. In: Handbook of Cross Cultural Psychology, vol. 2: Basic Processes and Human Development, 2d ed., ed. J.W. Berry, pp. 255–298. Boston: Allyn and Bacon.

Miller, G.F., and P.M. Todd. 1998. Mate choice turns cognitive. *Trends Cogn. Sci.* **2**:190–198.

Mineka, S., and M. Cook. 1988. Social learning and the acquisition of snake fear in monkeys. In: Social Learning. Psychological and Biological Perspectives, ed. T.R. Zentall and B.G. Galef, Jr. Hillsdale, NJ: Erlbaum.

Mullen, B. 1986. Stuttering, audience size, and the other-total ratio: A self-attention perspective. *J. Appl. Soc. Psych.* **27**:297–323.

Ortony, A., and T.J. Turner. 1990. What's basic about basic emotions? *Psych. Rev.* **97**:315–331.

Ritov, I., and J. Baron. 1990. Reluctance to vaccinate: Omission bias and ambiguity. *J. Behav. Decis. Mak.* **3**:263–277.

Rosenblum, L.A., and R.D. Nader. 1971. The ontogency of sexual behavior in male bonnet macaques. In: Influence of Hormones on the Nervous System, ed. D.H. Ford, pp. 388–400. Basel: Karger.

Scherer, K.R. 1984. On the nature and function of emotion: A component process approach. In: Approaches to Emotion, ed. K.R. Scherer and P. Ekman, pp. 293–318. Hillsdale, NJ: Erlbaum.

Scherer, K.R. 1999. Psychological models of emotion. In: The Neuropsychology of Emotion, ed. J. Borod. New York: Oxford Univ. Press

Schwartz, G.E., P.L. Fair, P. Salt, M.R. Mandel, and G.L. Klerman. 1976. Facial muscle patterning to affective imagery in depressed and nondepressed subjects. *Science* **192**:489–491.

Simonson, I. 1992. The influence of anticipated regret and responsibility on purchase decisions. *J. Consumer Res.* **19**:1–14.

Storms, M.D., and G.C. Thomas. 1977. Reactions to physical closeness. *J. Pers. Soc. Psych.* **35**:412–418.

Tetlock, P.E., R.S. Peterson, and J.S. Lerner. 1996. Revision the value pluralism model: Incorporating social content and context postulates. In: The Psychology of Values: The Ontario Symp. on Personality and Social Psychology, vol. 8, ed. C. Seligman et al., pp. 25–51. Hillsdale, NJ: Erlbaum

Tversky, A., S. Sattah, and P. Slovic. 1988. Contingent weighting in judgment and choice. *Psych. Rev.* **95**:371–384.

Tversky, A., and E. Shafir. 1992a. Choice under conflict: The dynamics of deferred decision. *Psych. Sci.* **3**:358–361.

Tversky, A., and E. Shafir. 1992b. The disjunction effect in choice under uncertainty. *Psych. Sci.* **3**:305–309.

Zajonc, R.B. 1965. Social facilitation. *Science* **149**:269–274.