How rational

DAVID HARDMAN *and* **CLARE HARRIES** *ask whether we need lessons in decision making.*

I N the areas covered by other articles in this special issue, as well as in many other domains, a major concern is whether the thought processes involved are suitable for producing the best outcomes. However, a wealth of evidence indicates that people do not generally think in accordance with the rational principles described by decision theory (for examples see Baron, 1994b). For some researchers this implies that people require education in decision-making techniques (e.g. Baron & Brown, 1991), but there are also some who question the appropriateness of rational models or claim that simpler processes can often be highly successful. In this article we review some of the research that addresses the tensions between these two viewpoints.

Violations of rational principles

The many published examples of people violating rational decision principles have generally been attributed to the nature of our subjective value and probability functions, to a general failure to think through all aspects of a decision, or to specific shortcuts used in judgement and decision making.

Consider the problems in the box below. The 70 people given Scenario 1 essentially had the same expected outcomes as those given Scenario 2. From a rational decision-theory perspective the two groups should behave in the same manner. However, the percentages show that they tended to behave differently: they were concerned with changes of wealth rather than final asset positions that include current wealth.

This 'value function' is part of the basis of prospect theory (Kahneman & Tversky, 1979; see Connolly *et al.*, 2000, for a simpler description). Not only are outcomes treated as gains or losses from a subjective reference point, but people are (a) cautious about obtaining gains, preferring sure-things over gambles, and (b) risk-seeking for losses – to avoid a certain loss they will take a gamble that could lead to an even bigger loss.

The value function also predicts framing effects, such as in the factory closure example described by Maule and Hodgkinson in this issue (p.68). In that problem, objectively identical outcomes were described in terms of the number of jobs lost or the number of jobs saved. Participants switched preferences according to which of these descriptions was used, supporting the idea that people are concerned with perceived gains or losses in relation to a subjective reference point.

Prospect theory is successful in describing and predicting a wide range of data, and it continues to be a leading theory of decision making. However, there are also non-supportive findings (e.g. Schneider, 1992; Wang, 1996), and there is no apparent rationale, for example, for the value function described above. The value functions and subjective functions are descriptive of behaviour but do not go beyond this. Furthermore, the theory proposes that decisions are made on the basis of a pre-processed, and possibly simplified, representation of the decision situation, yet there is no clear specification of the 'editing' processes that create the problem representation.

Other examples of the violation of rational principles are attributed to the apparent failure to think through the consequences of uncertain alternatives. For example, if you are awaiting the outcome of an examination then your future planning requires you to imagine two possible futures in which you have passed or failed the exam. In an experiment based on this scenario students were told to imagine they had just taken a tough qualifying examination. Most of those who were told the 'result' of the exam chose to buy a cheap holiday to Hawaii in a one-day special offer, *regardless of whether they had passed or failed*. However, students whose results were not yet released

---

THE VALUE FUNCTION

(adapted from Kahneman & Tversky, 1979)

1. In addition to whatever you own you have been given £1000. You are now asked to choose between:

	A:	a 50 per cent chance of £1000	B:	£500 for certain.
N = 70		[16 per cent]		[84 per cent]

2. In addition to whatever you own you have been given £2000. You are now asked to choose between:

	C:	a 50 per cent chance of losing £1000	D:	losing £500 for certain.
N = 68		[69 per cent]		[31 per cent]

are we?

preferred to pay a small deposit to defer the holiday decision until after the exam results were obtained, which suggests that they had not thought through the consequences of passing or failing – namely that they might feel the need either to celebrate if they passed or take a break anyway if they failed (Shafir *et al.*, 1993). The behaviour of participants in this study is a violation of Savage's 'sure-thing principle': If you prefer A to B in all possible states of the world (most wanted to go whether they had passed or failed), then you should prefer A to B in any particular state of the world.

Other systematic violations of rationality ('biases') have been attributed to specific shortcuts or 'heuristics' (e.g. Kahneman *et al*., 1982). Consider 'the Linda problem' (see box). In a study by Tversky and Kahneman (1983) 85 per cent of respondents indicated that Linda was less likely to be a bank teller than both a bank teller and a feminist. However, because the set of women bank tellers includes, and must be at least as large as, the set of women who are both bank tellers *and* feminists, it is wrong to suppose that Linda is more likely to be both. According to the representativeness heuristic, people overlook the basic principles of probability

THE LINDA PROBLEM
(from Tversky & Kahneman, 1983)

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Please rank the following statements by their probability, using 1 for the most probable and 8 for the least probable.

a) Linda is a teacher in a primary school.
b) Linda works in a bookstore and takes Yoga classes.
c) Linda is an active feminist.
d) Linda is a psychiatric social worker.
e) Linda is a member of Women Against Rape.
f) Linda is a bank teller.
g) Linda is an insurance salesperson.
h) Linda is a bank teller and is an active feminist.

and make their judgements according to the perceived similarity between the statement and the description of Linda.

The optimistic view of judgement and decision making

A focus on biases and a 'rhetoric of irrationality' (Lopes, 1991) has overshadowed the central idea of heuristics, which is that they were supposed to be useful in providing reasonable solutions much of the time, given our limited cognitive capacity. Simon (1956) criticised rational models of decision making for ignoring situational and personal

constraints, such as time and cognitive capacity. He proposed that the mind had evolved short-cut strategies that delivered reasonable solutions to real-world problems, an idea that he referred to as 'bounded rationality'.

Over the years a number of decision strategies have been proposed whereby people avoid effortful trade-offs between the good and bad points of an option. These are known as non-compensatory strategies. Examples are Simon's (1957) 'satisficing' heuristic (see Maule & Hodgkinson, this issue) and 'elimination-by-aspects' (Tversky, 1972). To illustrate the latter, imagine that you are looking for a new car, and the most important feature is petrol consumption. You begin by comparing all cars on that criterion, and eliminate from consideration any models that fall short. Then you compare the remaining cars on the next most important feature, and so on.

Payne *et al.* (1993) found that simple strategies such as those described above may be used to reduce the choice set before applying a more complex (trade-off) strategy to the remaining alternatives. Thus, for example, having eliminated all cars that have poor petrol consumption and all cars that are above your price range, you may compare three remaining models simultaneously on the grounds of colour, shape, headroom and luxury of the interior, assessing each in terms of these variables and giving them different weights. Although simple strategies may precede more complex ones, computer simulations

indicated that the simple non-compensatory strategies can actually be highly effective in terms of achieving desirable outcomes.

Performance using simple heuristics may depend on the nature of the task. In the field of probability judgement Tversky and Kahneman (1983) and others have found that conjunction errors (see the Linda problem above) greatly decrease when the task instruction following the personality sketch reads as follows:

There are 100 people who fit the description above. How many of them are (a) bank tellers, (b) bank tellers and active feminists.

Some researchers argue that people are evolutionarily adapted to reason about naturally sampled frequencies (e.g. sequences of events) rather than single events (e.g. Gigerenzer & Hoffrage, 1995; see also Cosmides & Tooby, 1996). However, on some problems the size and source of such format effects are disputed (e.g. Evans *et al*., 2000; Harries & Harvey, 2000). Furthermore, people sometimes fail to apply statistical knowledge that they possess. When forecasting how long it will take to complete a project, people may fail to consider previous projects they have undertaken. Rather, they take an 'inside view' of the current project, thinking only about their plans and scenarios leading to successful completion (Kahneman & Lovallo, 1993). This results in overly optimistic forecasts. (We see this annually with final-year undergraduate projects!)

Following Brunswik (1952), another strand of research attempts to model the environment, as well as the judgement or decision, in terms of the available information. The predictability of a person's performance can be seen in relation to the predictability of the environment. For example, how well does a particular medical symptom predict the existence of a particular disease? Brunswik emphasised that humans can learn about the probabilistic relationships between information and a criterion and can learn to substitute different pieces of information for each other. Research in this area has examined the integration of multiple cues to produce a judgement or decision, and has typically relied on regression analysis to determine which factors are most predictive (Cooksey, 1996; Doherty & Kurz, 1996; see also Hammond & Stewart, 2001).

More recently Gigerenzer and colleagues (1999) have rejected the notion

that people are computing regression equations when making judgements, in favour of the use of 'fast and frugal' heuristics. They argue that information in the environment is structured such that a *single* cue can be good enough (i.e. highly predictive) for us to make very accurate judgements or decisions. In other words, good judgements and decisions can often be made on the basis of one reason. For example, whether a German city has a football team in the Bundesliga is a valid (but not infallible) cue to city size: a city that does is likely to be larger than one that does not.

But perhaps the simplest reason for making a decision is the fact that you recognise something. This can be a very profitable strategy: Borges *et al.* (1999) found that stock portfolios constructed on the basis of company name recognition were more successful than those constructed by business students on the basis of knowledge. Stock portfolios involving foreign companies are also more likely to be based on name recognition than those involving home companies, because there is less knowledge available. Indeed, with both German and American students the researchers found superior performance for foreign stock portfolios over home portfolios.

Gigerenzer's work explicitly draws on Simon's notion of bounded rationality, though using the term *ecological rationality* to refer to the match between mind and environment that is emphasised in their work. Gigerenzer and Goldstein (1996) have used computer simulations to show that judgements based on single reasons such as this are at least as accurate as judgements based on the integration of several items of information. However, some authors are critical of the assumptions underlying this approach (see

e.g. the exchanges in *Behavioral and Brain Science*s, *2*(5), 727–780).

The effectiveness of simple decision strategies is supported by research from naturalistic decision making (NDM). Much of this research studies important real-life decisions made by experts under conditions of time pressure and stress. A typical finding is that decision makers rarely consider more than one course of action at a time. According to the 'recognition-primed' theory of decision making (Klein, 1998), a decision maker mentally simulates the consequences of following the same course of action that worked on a previous occasion. Only if this simulation is not acceptable does the decision maker consider some alternative course of action. In essence, expert decision makers are using Simon's satisficing heuristic.

So should we teach rational decision making?
The view of the optimists seems to imply that the teaching of rational decision-making techniques may be unnecessary; the current cognitively constrained behaviours are suited to the environment. Indeed, one implication of NDM research, according to Klein, is that it may be counterproductive to attempt to teach experts 'rational' decision-making techniques. Rather they should undergo intensive training involving exposure to a range of different scenarios.

From a Brunswikian perspective this allows people to gain an understanding of the underlying structure of the environment. However, it relies upon receiving the sort of outcome feedback that is often unavailable in real life. For example, jurors will usually never know whether they imprisoned the wrong person. More typically, behaviour is changed using cognitive feedback in the form of ideal

weighting of information given the environmental structure.

Another approach is to change aspects of the environment to fit people's inherent information-processing behaviour. As described above, the specific wording of some probability problems has been shown to facilitate reasoning performance. In another domain, Klayman and Brown (1993) found that medical diagnosis was improved when training involved the presentation of contrasted information about two diseases rather than learning about those diseases separately. A decision aid may take doctors and patients through a series of steps in which they discover underlying preferences, possible options and which course of action is actually the best one.

It is important to consider a range of situations in which rationality in both personal and public policy decisions can be undermined by certain intuitions (see Baron, 1994a, 1998). For example, we generally consider it important to avoid doing harm through our actions, but are sometimes willing to risk harm through inaction. In one study many participants voted against hypothetical social reforms that they agreed would be beneficial overall, often on the grounds that some

people would nonetheless be worse off (Baron & Jurney, 1993).

This 'do no harm' intuition can influence people's willingness to vaccinate a child where the vaccine itself carries some smaller risk of harm. Similarly, public policies on new drug testing are more concerned with the harm that could be done from a drug than with the potential benefits that are being denied as a result of costly testing procedures and fear of lawsuits. Media coverage of possible or actual drug side-effects is common, but there are rarely media campaigns for the development of new drugs.

This reluctance to make trade-offs suggests that education in rational decision-making techniques may be of value, at least in situations not seriously constrained by time pressure. For example, school students who have had classes in rational decision making could put this into practice in their choice of examination subjects, universities, and later important life decisions.

Conclusions and implications

The idea of bounded rationality in judgement and decision making has proved to be a powerful one, motivating the search for various mental shortcuts in thinking. However, an overemphasis on errors in

thinking may have helped lead to a view of people as 'irrational'. This article has reviewed other evidence that shows people in a more positive light. Moreover, recent research is developing the ideas of Brunswik and Simon that cognitive mechanisms are linked to the structure of the environment.

Despite the shift towards the optimistic camp in judgement and decision making, there are still questions to be addressed relating to contemporary decision environments in which our evolved thought mechanisms may not be particularly helpful (Ayton & Wright, 1994). For example, it is hard to see how heuristic thinking by jurors could be of benefit to the legal process, and researchers are keen to identify the kinds of context that will facilitate a more analytical mode of thought (see Honess & Charman, this issue). In some situations decision education and decision-analytic techniques may be of use. However, the effectiveness of such methods, though widely assumed, is largely untested (Clemen, 1999) and perhaps even doubted (Klein, 1998). What is needed is an investigation of specific decision domains, and whether factors that optimise performance in one domain also help in another domain.

References

Ayton, P. & Wright, G. (1994). Subjective probability: What should we believe? In G. Wright & P. Ayton (Eds.) *Subjective probability*. Chichester: Wiley.

Baron, J. (1994a). Nonconsequentialist decisions. *Behavioral and Brain Sciences, 17*, 1–42.

Baron, J. (1994b). *Thinking and deciding* (2nd edn). Cambridge: Cambridge University Press.

Baron, J. (1998). *Judgment misguided: Intuition and error in public decision making*. Oxford: Oxford University Press.

Baron, J. & Brown, R.V. (1991). Why Americans can't think straight. In J. Baron & R.V. Brown (Eds.) *Teaching decision making to adolescents*. Hillsdale, NJ: Lawrence Erlbaum.

Baron, J. & Jurney, J. (1993). Norms against voting for coerced reform. *Journal of Personality and Social Psychology, 64*, 347–355.

Borges, B., Goldstein, D.G., Ortmann, A. & Gigerenzer, G. (1999). Can ignorance beat the stock market? In G. Gigerenzer, P.M. Todd and the ABC Research Group (Eds.) *Simple heuristics that make us smart* (pp.59–72). New York: Oxford University Press.

Brunswik, E. (1952). *The conceptual framework of psychology*. International Encyclopedia of Unified Science Vol. I no. 10. Chicago: University of Chicago

Press.

Clemen, R.T. (1999). Does decision analysis work? A research agenda. Draft manuscript. Duke University, North Carolina.

Connolly, T., Arkes, H.R. & Hammond, K.R. (Eds.) (2000). *Judgment and decision making: An interdisciplinary reader* (2nd edn). Cambridge: Cambridge University Press.

Cooksey, R.W. (1996). *Judgment analysis: Theory, methods, and applications*. San Diego, CA: Academic Press.

Cosmides, L. & Tooby, J. (1996). Are humans good intuitive statisticians after all? Rethinking some conclusions from the literature on judgment under uncertainty. *Cognition, 58*, 1–73.

Doherty, M.E. & Kurz, E.M. (1996). *Social Judgement Theory. Thinking and Reasoning, 2*(2/3), 109–140.

Evans, J.StB.T., Handley, S.J., Perham, N., Over, D.E. & Thompson, V.A. (2000). Frequency versus probability formats in statistical word problems. *Cognition, 77*(3), 197–213.

Gigerenzer, G. & Goldstein, D.G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. *Psychological Review, 103*, 650–669.

Gigerenzer, G. & Hoffrage, U. (1995). How to improve Bayesian reasoning without instruction: Frequency formats.

Psychological Review, 102, 684–704.

Gigerenzer, G., Todd, P.M. and the ABC Research Group (Eds.) (1999). *Simple heuristics that make us smart*. New York: Oxford University Press.

Hammond, K.R. & Stewart, T.R. (Eds.) (2001). *The essential Brunswik: Beginnings, explications, applications*. Oxford: Oxford University Press.

Harries, C. & Harvey, N. (2000). Are absolute frequencies, relative frequencies, or both effective in reducing cognitive biases? *Journal of Behavioral Decision Making, 13*, 431–444.

Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*, 263–291.

Kahneman, D. & Lovallo, D. (1993). Timid choices and bold forecasts: A cognitive perspective on risk taking. *Management Science, 39*(1), 17–31.

Kahneman, D. Slovic, P. & Tversky, A. (1982). *Judgment under uncertainty: Heuristics and biases*. Cambridge: Cambridge University Press.

Klayman, J. & Brown, K. (1993). Debias the environment instead of the judge – An alternative approach to reducing error in diagnostic (and other) judgment. *Cognition, 49*, 97–122.

Klein, G. (1998). *Sources of power: How people make decisions*. Cambridge, MA: MIT Press.

Lopes, L.L. (1991). The rhetoric of irrationality. *Theory & Psychology, 1*(1), 65–82.

Payne, J.W., Bettman, J.R. & Johnson, E.J. (1993). *The adaptive decision maker*. Cambridge: Cambridge University Press.

Schneider, S.L. (1992). Framing and conflict: Aspiration level contingency, the status quo, and current theories of risky choice. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 1040–1057.

Shafir, E., Simonson, I. & Tversky, A. (1993). Reason-based choice. *Cognition, 49*, 11–36.

Simon, H.A. (1956). Rational choice and the structure of environments. *Psychological Review, 63*, 129–138.

Simon, H.A. (1957). *Models of man: Social and rational*. New York: Wiley.

Tversky, A. (1972). Elimination by aspects: A theory of choice. *Psychological Review, 79*, 281–299.

Tversky, A. & Kahneman, D. (1983). Extensional versus intuitive reasoning: Conjunction fallacy in probability judgment. *Psychological Review, 90*, 293–315.

Wang, X.T. (1996). Framing effects: dynamics and task domains. *Organizational Behavior and Human Decision Processes, 68*, 145–157.