2

The Many Faces and Masks of Uncertainty

Michael Smithson

INTRODUCTION

Uncertainty is a topic that does not fall neatly within a single discipline. Instead it sprawls across a considerable variety of disciplines, professions and problem domains. Consequently, there is no cogent, readily identifiable body of literature on uncertainty. The topic lacks a home. The relevant literature is scattered throughout the entire realm of intellectual culture. The terms employed by various traditions to refer to uncertainty are themselves multifarious, and as a result researchers and scholars from different traditions have difficulty communicating effectively with one another.

It is difficult to communicate clearly about uncertainty, and even more difficult to find out very much about it. However, it is not so difficult to find out how people talk about uncertainty, what they think it is, and how they deal with it. To a large extent, that is what this book is about. The purpose of this chapter is to equip readers with several concepts, strategies and questions that may assist in understanding the chapters that follow. Accordingly, here is a brief outline of the destinations on our tour through uncertainty in this chapter.

The first section concerns views about the nature of uncertainty. Every discipline and profession has (often implicit) assumptions and beliefs about the 'unknown'. Some think there is only one kind of uncertainty; others think there are many kinds. These views encompass questions such as whether there are irreducible uncertainties, when information or knowledge is worth acquiring, and how uncertainty is produced.

The second section deals with motives and values that people associate with uncertainty. Common metaphors about uncertainty reveal not only how we think about it but how we feel towards it. We adopt ethical and moral stances

towards uncertainty. What underpins our judgments of which uncertainties are 'bad' or 'good', which are exchangeable, and which can be blamed on people? Despite a generally negative bias towards uncertainty, people do have uses for it – what are they? Uncertainty is not always a negative aspect of human affairs. In fact, it is an essential component in social relations, organizations and culture. People are motivated to create and maintain uncertainty, rather than always trying to reduce or banish it. Uncertainty also presents genuine dilemmas in management and control.

The third section raises the question of how people deal with uncertainty. Despite the fact that we do this every day, only recently has it become an object of systematic research. Coping strategies may range from fatalism to optimistic (even heroic) interventionism. Likewise, various alternative managerial approaches to uncertainty are open to consideration and often are contested.

THE NATURE OF UNCERTAINTY

How do people represent uncertainty and communicate about it? Is there more to it than mere absence of knowledge? Can various uncertainties be compared or even quantified? Where do our ideas about uncertainty come from? At first glance, uncertainty might seem uncomplicated – after all, isn't it merely the lack of sure knowledge? A little more thought, however, suggests uncertainty is not as simple as that.

Imagine that Amy is fortunate enough to participate in a game of 100 coin tosses in which every time a fair coin is tossed and comes up Heads, she receives $1. While we may be uncertain about how much money Amy will receive from this game, we can still calculate an expected amount by multiplying the probability of Heads (1/2) by $1 by 100 tosses, which comes to $50. We could even go on to calculate the probability that she will get any possible monetary amount from the game, from $0 to $100. The uncertainty regarding the outcome of the game is probabilistic. It is quantifiable.

Now consider a situation where all we know is that Amy is going to be bequeathed a sum of money anywhere from $0 to $100. We cannot apply probability theory here. Even the notion of averaging $0 and $100 to get an 'expected' value of $50 is contentious because we have no good reason to prefer $50 to any other estimate between $0 and $100. The type of uncertainty in this situation is not captured by probability, it is *vagueness*. It is not readily quantifiable.

Readers will encounter many different kinds of uncertainty in this book, but they will also encounter disciplines using the same terms for uncertainty in different ways. While life might be simpler if everyone shared the same definitions, there is much to be gained from appreciating the variety of viewpoints. The widely scattered literature on this topic lacks an agreed nomenclature, but let us begin by considering a term for the overarching concept in this domain. Böschen and Wehling (2004) use the term '*nichtwissen*' (the English equivalent is

'nonknowledge'). A relatively popular if more radical alternative is 'ignorance' (Moore and Tumin, 1949; Smithson, 1985 and 1989; Merton, 1987). Knorr-Cetina (1999) introduces the term 'negative knowledge', in other words knowledge of the limits of knowing, mistakes in attempts to know, things that interfere with knowing and what people do not want to know. Outside the social sciences the most popular generic term seems to be 'uncertainty'; this is, for example, the case in artificial intelligence (Krause and Clark, 1993) and in economics (see Chapter 17).

Knorr-Cetina (1999) and Smithson (1989) make the important observation that anyone referring to uncertainty cannot avoid claiming to know something about who is uncertain about what. Smithson's (1989) definition handles this issue by stating that A is uncertain from B's viewpoint if A fails to agree with or show awareness of ideas which B defines as actually or potentially valid. This definition allows B to define what she or he means by uncertainty. It also permits self-attributed uncertainty, since A and B may be the same person. Most important, it incorporates the possibility that A and B might not agree about uncertainty. Uncertainty does not simply impose itself on us from the natural world; it is socially constructed. Cultures differ considerably in how uncertainty is conceived and expressed, and so do subgroups within the same culture. It probably does not matter greatly what generic term we choose as long as our definition of it recognizes this point.

People also behave as if there are different kinds of uncertainty and as if that matters to them. If we want to understand how people orient towards uncertainty, we need to take such distinctions into account. How can we assess which distinctions are worth making? Smithson (in press) suggests four criteria, namely whether candidate kinds of uncertainty:

1 are consistently distinguished from other kinds when referred to in communication by members of the same linguistic community;
2 are accorded statuses or roles distinct from other kinds in the same situations or for the same purposes in social interaction;
3 produce different social consequences for those to whom they are attributed; and/or
4 are (dis)preferred to other kinds of uncertainty.

For instance, in relation to the first criterion, if we wish to understand how artists have employed 'chance' in art-making (see Chapter 10) versus how statisticians or probabilists work with 'chance' (Chapters 7 and 8), then we should start by understanding what artists and statisticians mean by this term and how they use it rather than immediately insisting on our own terms or definitions. An example fulfilling the second criterion in my list is the commonsense observation that conveying outright misinformation (distortion) is socially riskier than conveying vague or partial information for purposes of being tactful.

Correspondingly, the third criterion is exemplified by the belief that the consequences of being found out uttering a falsehood will be worse than being found out omitting part of a truth. Evidence for both propositions stems from studies such as Burgoon and colleagues' 1994 investigation of equivocation or omission versus falsification in doctor–patient interviews, in which about 85 per cent of the participants admitted to omission but only 34 per cent admitted to falsification. Likewise, in many situations people will provide a vague statement in order to avoid being judged afterwards to have been wrong, because it is easier to deny particular interpretations of vague statements. Finally, an example of the fourth criterion is evidence that for many people probabilistic uncertainty is preferred to ambiguity (Ellsberg, 1961), which in turn is preferred to conflict (Smithson, 1999).

One additional important concept to add to our mental toolkit is metacognition about knowledge and uncertainty. The most popular distinction is between knowing that we don't know and not knowing that we don't know (Smithson, 1989; Kerwin, 1993; Ravetz, 1993). In his dialogue with Meno, Socrates pointed out the difference between what he called 'ignorance' and 'error'. People in error believe they know that which they do not know, while ignoramuses are conscious of their lack of knowledge. Merton (1987) described a similar distinction between 'unrecognized' and 'specified' ignorance, with the latter being useful for focusing further inquiries or learning. I prefer the terms 'meta-ignorance' and 'conscious ignorance'.

METAPHORS, MOTIVES AND MORALS

Where do our ideas about uncertainty come from? Smithson (in press) points to two sources: commonsense realism and commonsense sociality. Commonsense realism encompasses everything we believe or think about how the non-social world works. Commonsense sociality refers to our beliefs about the social world and includes our commonsense ideas about people. The main reason for distinguishing these two sources is that a number of important characteristics we attribute to people (for example intentions) we do not attribute to objects in the non-social world, and that has direct consequences for how our commonsense theories direct us to think about uncertainty.

Although out intuitions about uncertainty may be socially constructed, we should bear in mind that some of them appear to be shared with other species and may have been selected in evolutionary processes. Many species (including ours) behave as if events or influences that are nearby or in the near future are more certain than those farther away or further into the future (see Rachlin, 1989, for an excellent overview of the research on delay). The underlying metaphor is that certainties are here and now. Uncertainties are later and farther away. Distance is uncertainty. Delay is uncertainty. Moore's chapter on politics (Chapter 15) devotes an entire section to the use of delay as a political tool,

highlighting the fact that with delay comes uncertainty. And as Hájek (Chapter 8) points out in his survey of probability theories, normalized quantities such as distance and time may have nothing to do with probabilities but still may exhibit identical formal (mathematical) properties.

Common metaphors for uncertainty are highly informative about how it is regarded and used in a society. Following Lakoff and Johnson (1980), here is a sample from English-speaking cultures of ten metaphors for uncertainty that stem from commonsense realism:

1 Uncertainty is obstructed vision. Uncertainty is blindness. To know is to see. Vague ideas are blurry, murky, hazy, unclear, obscured. Knowledge is brilliant, illuminating and enlightening. Uncertainty is dim and dark.
2 Ideas can be felt. Vague or uncertain ideas are soft and woolly. Objective knowledge, truth and logic are hard. Incomplete ideas are rough.
3 Learning and discovery are a journey. To know or discover is to arrive at a destination. A path can be cleared or paved to help us learn or discover. Learning is finding one's way. Uncertainty is straying from the path, getting lost, going in the wrong direction, going around in circles, wandering aimlessly, failing to arrive.
4 The unknown is an ocean. Knowledge is an island. The bigger the island, the larger the border between the known and unknown.
5 The unknown is wilderness. Knowing is domesticating and taming the wild. The border between the known and unknown is a wild frontier. Learning and discovery push back the frontier, diminishing the extent of the unknown.
6 Seeking knowledge is gathering and hunting. The unknown is prey. Sought-after ideas, facts and truths can be elusive, hard to find, slippery. They can be apprehended, grasped or homed in on. They can also escape. Errors or bad ideas are off-target, wide of the mark.
7 Ideas are food (for thought). Bad ideas are half-baked or even raw. Raw data have yet to be cooked into knowledge. Thinking or analysing is cooking.
8 Uncertainty is gaps or holes. Knowledge covers a surface or fills a container. An ignoramus is devoid of knowledge, whereas an expert is brimming with knowledge. An incomplete theory has holes or gaps, whereas a complete theory covers the terrain.
9 Ideas, theories and arguments are buildings. Uncertain or erroneous ones are shaky, badly constructed, unfounded. They collapse, don't hold together, fall apart, can be knocked down.
10 Uncertainty is variability. Certainty is constancy.

Likewise, here is a sample of ten metaphors stemming from commonsense sociality:

1 Inquiry is invasion. Learning is conquering. Uncertainty is conquered or overcome by knowledge and ideas.
2 Ideas and knowledge are resources. Knowledge and information are currency. Uncertainty is poverty. Bad ideas are worthless, bankrupt. An expert has a wealth of knowledge.
3 Argument is war. Rational argument is still war. Ambiguity or indecision is internal war.
4 Knowledge is power. ~~Uncertainty~~ is helplessness and impotence. Uncertainty or doubt is still impotence. We succumb to uncertainty.
5 Uncertainty is being stuck, enslavement. Knowledge makes you free.
6 Innocence is chastity. Scepticism, doubt or uncertainty is still chastity. To be known is to be violated. To believe or be persuaded is to be seduced.
7 Information exchange is sexual intercourse. Good ideas are fertile and can procreate. Bad ideas are sterile or barren.
8 Ignorance is inequality. Shared knowledge is generosity, democracy, freedom. Unshared knowledge is selfishness, autocracy, elitism, oppression. Secrecy is selfish. Privacy and expertise are elitist.
9 The unknown is a secret. Even nature keeps secrets. The unknown is locked away. Discovery or learning is unlocking and revealing.
10 Uncertainty is insecurity and fear. We are afraid we don't know. Certainty is confidence.

It should be apparent that most of the metaphors regarding uncertainty have a negative cast to them. The negative stance towards uncertainty is a mainline thesis pervading Western culture to the extent that, as Smithson (1993 and in press) points out, Western intellectual culture has been effectively blinded to most of the positive functions uncertainty performs. Of course, there are excellent reasons in many circumstances to be negatively disposed towards uncertainty. In this volume, Plant's chapter on infectious disease outbreaks (Chapter 4), Longford's on intelligence (Chapter 19) and Handmer's on emergency management (Chapter 20) all are good cases in point, because they highlight the need for effective ways of being decisive where uncertainty is essentially an antagonist.

Nevertheless, uncertainty can motivate people positively as well as negatively. People find uses for uncertainty and do not always want to be rid of it. Readers having difficulty conceiving of positive aspects of uncertainty might wish to consider what freedom, discovery, creativity and opportunity really require, namely uncertainties about what the future will bring so that there actually are choices to be made. No uncertainty, no freedom. In this volume, Mackey's chapter on jazz improvization (Chapter 9) and Grishin's overview of how visual artists have employed aleatory devices to open up creative possibilities (Chapter 10) provide ample demonstrations of this fundamental connection. Curthoys' meditation on the double character of history as both science and narrative art (Chapter 11) and Buckman's account of how physicists

have come to grips with irreducible uncertainties in an 'exact' science (Chapter 6) illustrate the mixed motives that people often possess when it comes to uncertainty. Indeed, Horgan's book *The End of Science* (1996) was reviled by many scientists in part because its central thesis – that science is running out of unknown things to discover – is quite dismaying to scientists. Ignorance is treated by Horgan as a resource that must be replenished to feed the insatiable appetite of science.

In a somewhat more sinister vein, people may use the deliberate production of ignorance and uncertainty as a way to dominate or manipulate others. Proctor's (1995) work on the tobacco industry's efforts to manufacture doubt about the hazards of tobacco is an excellent case study of the use of pseudoscience by an industrial giant to protect and expand its investments. Likewise, Michaels has elaborated the thesis that opponents of health and environmental regulation are able to prosecute their ends 'without being branded as anti-environmental, by focusing on scientific uncertainty and by manufacturing uncertainty if it does not exist' (Michaels, 2005 pS43).

People regard some kinds of uncertainty as having moral antecedents and consequences. Imposing or increasing risks for other people, for instance, is widely regarded in the Western world as morally bad (see Furedi, 2002, for an extended polemic regarding the moralizing aspects of risk perception and management). In earlier times and in some present-day cultures, attempting to alter uncertainties has been perceived as spiritually dangerous or even blasphemous (Bernstein, 1996). As Pickard points out in Chapter 5, for religious fundamentalists any consideration of uncertainty regarding their religious tenets is off limits.

Throughout Western societies and their institutions, we find numerous laws and structures championing people's rights to knowledge. Democracy and secrecy, it would seem, are incompatible. On the other hand, it is not difficult to find examples of 'virtuous' uncertainty and secrecy in the same Western cultures. Would it be a good thing if everyone knew the location of the Wollemi Pines?[1] On a more mundane but also more general level, how would politeness (for example tact or white lies) be possible without the deliberate creation and maintenance of uncertainty? What would gift-giving be like if surprises were forbidden? As Smithson (1989) points out, politeness often operates via disinformation (for example promoting a false impression of approval), or by referential abbreviation (particularly vagueness and ambiguity, as in tactful utterances). In their 1997 book on miscommunication, communications scholars Mortensen and Ayers clearly align themselves with 'the ideal of maximum communicative value – clarity, fluency and explicitness' (pp69–70). But they are compelled to acknowledge that there are plenty of occasions where prevarication and even deception are socially acceptable, ranging from mundane concerns such as protecting the feelings of others to rather grandiose issues such as protecting life or maintaining national security (pp70–71).

Contrary to the view of ignorance and uncertainty as primarily negative, human engagement with ignorance or uncertainty is almost always a mixed-motive enterprise. People sometimes are motivated to discover or create, maintain and use uncertainty. The very concept of research, for example, presupposes conscious uncertainty about the object of research at the outset; otherwise there is nothing to research. Much the same is true of artistic creations.

People can have quite defensible reasons to remain ignorant about information directly relevant to themselves, even when that information is readily available. The uptake rate on genetic marker tests by individuals with a hereditary risk of a life-threatening disease such as Huntington's Chorea or colon cancer is notoriously low, and the same is true regarding the diagnosis of carrier status of such conditions (see, for example, Fanos and Johnson, 1995). More 'positive' examples include the majority of parents-to-be not wanting to know the gender of their unborn child (Wilson et al, 2005), social arrangements such as surprise gift-giving, entertainment (for example avoiding prematurely finding out about the ending of a novel or film), and games.

Why do (or should) we care about uncertainty? I propose here that our primary interests in uncertainty stem from four adaptive challenges that we routinely face:

1 dealing with unforeseen threats and solving problems;
2 benefiting from opportunities for exploration and discovery;
3 crafting good outcomes in a partially learnable world; and
4 dealing intelligently and sociably with other people.

The first point is perhaps obvious to most of us. After all, this has been the main thrust of Western intellectual and technical culture at least since the Enlightenment. Many of the chapters in this book place this concern at centre stage. Ritter (Chapter 14) characterizes the issue of heroin dependency in terms of three problem arenas, each with their own kinds of uncertainty: epidemiology and etiology, policy formulation, and treatment of dependent users. Dovers and colleagues (Chapter 21) find the scientific and policy domains of sustainability are pervaded by uncertainty, due to extended time scales, complexity, and competing values and knowledge claims, in addition to mere lack of information. McFadden and colleagues (Chapter 22) expand the law-enforcement charter regarding anti-terrorism to include the reduction of uncertainty in the community through transparency and accountability. Likewise, Handmer's chapter on emergency management (Chapter 20) emphasizes the observation that emergency managers cannot wait for certainty; they must act under increasing scrutiny from a variety of powerful stakeholders.

The second point has already been canvassed in this chapter but usually is neglected when we think about uncertainty. The most obvious examples of how

people benefit from opportunities for exploration, discovery, entrepreneurship and creativity thrown up by uncertainty are in the intellectual domains of the arts and sciences and the practice domains of politics and business. But Pickard (Chapter 5) raises quite similar points in the realm of religion, first by observing that for some theologians doubt is an intrinsic component of faith (in other words that faith is not reducible to certitude) and then linking religious uncertainty with the innovative potential of religion itself.

The third point is closely related to the first, with the added caution that some uncertainties are irreducible and the world is only partially learnable. Quiggin (Chapter 17) provides a sobering realization that only recently has work begun in economics on modelling economic behaviour for situations where decision-makers do not know all of the possible outcomes beforehand. Moore's chapter on politics (Chapter 15) invites the reader into a realm where this is the everyday state of affairs; Perez's chapter on complexity science (Chapter 13) introduces readers to a field in which this state of affairs is taken as given; and Delaney's survey (Chapter 12) reveals that assuming crucial aspects of the future are unknowable forms the basis for much work in futurology.

The fourth point merits some elaboration, although it raises complex issues far beyond the scope of this chapter. To begin with, numerous social relations depend on systematic uncertainty arrangements. I will provide just one example. Trust has long been recognized as a major contributor to social capital (see, for example, Fukuyama, 1995). Despite long-running debates about the nature of trust, there is widespread agreement among scholars that trust 'entails a state of perceived vulnerability or risk' (Kramer, 1999, p571). A primary source of that risk is a virtual requirement that the trusting remain partially ignorant about the entrusted. If a person believes another is monitoring them or insisting that they self-disclose or account for their actions, that person will infer that the other does not trust them.

Likewise, there are plenty of pragmatic and political motives for creating and using uncertainty. Uncertainty or the lack of knowledge can be used as a justification for evading culpability or responsibility, for example. And as Moore observes in his chapter on political practice (Chapter 15), it is generally safer for politicians to ally themselves with uncertain progress than to have clear, measurable goals where success and failure are unambiguous.

COPING AND MANAGING UNDER UNCERTAINTY

Various chapters in this volume describe, criticize or recommend ways of dealing with uncertainty. The integrative chapter on coping with uncertainty (Chapter 26) provides an overview of those chapters. Here, I present a brief survey of the central issues entailed in dealing with uncertainty. Human strategies for managing under uncertainty are typically oriented towards the issues of how uncertainty can be:

- understood;
- represented, quantified or estimated, and communicated;
- eliminated or reduced;
- accepted or tolerated; and
- controlled, harnessed or exploited.

Clearly many such strategies address only subsets of these issues, but, as a whole, this list is intended to be exhaustive. Most strategies, nevertheless, are attempts to incorporate mixed (and sometimes conflicting) motivations regarding uncertainty and one or more of the adaptive challenges listed earlier.

Starting with understanding and representing uncertainty, a large body of cognitive psychological research suggests that people use cognitive shortcuts and selective attention to make decisions under uncertainty, rather than attempting laborious (and in some cases impossible) computations or a comprehensive understanding of uncertainties. People also tend to regard alternatives that have missing information as inferior to those where the informative content is complete, and they become more indecisive in the face of uncertainties that make decisions more difficult (Anderson, 2003). So here we find motivations for and against the explicit representation of uncertainty that will be explored in Chapter 26. We will see that some domains have clear mandates for quantifying and calculating uncertainties, whereas others have equally clear injunctions against doing so.

Tetlock (2002) extends this theme to describing how people deal with social uncertainty; his templates are the 'intuitive politician', 'intuitive prosecutor' and 'intuitive theologian'. The relevant adaptive challenges here are dealing with accountability, negotiating or defending the ground-rules for accountability, and protecting sacred values or ideals. Those challenges in turn influence whether people deal with uncertainty by eliminating, tolerating or exploiting it.

Many institutional practices involve adaptive mixed-motive dealings with uncertainty. The interface between legislated policy and judiciary practice is fraught with uncertainties that simultaneously present interpretive difficulties and enable flexibility and adaptability. As Jones points out in Chapter 23 on environmental law (and as Durkheim averred long ago), there is constant pressure to adapt laws to changing circumstances, giving rise to controversy about the extent to which new judgements change the law. Well-written policy often must be vague enough to be adaptable and usable in unforeseeable circumstances, albeit at the expense of short-term ease of interpretation.

Professionals, politicians and risk managers must also contend with stakeholder perceptions of uncertainty and the competing interests invoked thereby. As Brown (2004) observes, discussions and increased interest in scientific uncertainties have started to filter into policy formation. An example is the new European Union Water Framework Directive requirement that scientific uncertainty is addressed within the development of integrated water management plans at a European scale. In another related arena, the nature and determinants

of public risk perception have been hotly contested for more than three decades, and at the heart of these debates is a long-running argument over the veridicality of such perceptions and the presentation of risks by outlets such as the media. In the 'social risk amplification' framework, for instance, the core concern is whether risk communication produces (in)appropriate intensification or (in)appropriate attenuation of public risk fears. As Leiss (2003, p357) makes clear, risk managers and policymakers have interests directly vested in these outcomes, especially inappropriate intensification or attenuation. Here, the potential for public ignorance about risk (as viewed by managers and policymakers) provides justifications for managerial decisions or policy directives.

In settings characterized by competing interests, it is not difficult to find examples of tradeoffs or even genuine dilemmas in dealing with uncertainty. I previously (Smithson, 1989) somewhat inaccurately referred to both tradeoffs and dilemmas as 'dilemmas', but the distinction between them is worth preserving. Tradeoffs amount to perceiving uncertainty as both a good and a bad thing simultaneously, sometimes simultaneously for the same agent. In dilemmas, on the other hand, the pursuit of self-interest by too many actors results in poor outcomes for everyone. Nevertheless, the actors are motivated to pursue self-interest out of fear (of being played for a sucker) and/or greed (the possibility of taking advantage of others). I will conclude this section with a few examples of uncertainty tradeoffs and dilemmas.

'Collingridge's Dilemma' (Smithson, 1989) is really just a tradeoff problem. The less well entrenched a system is and the shorter the time it has been operating, the more easily and inexpensively it can be changed, but the greater is our ignorance of its likely effects or problems. By the time ignorance of those effects has been reduced, it is too expensive and difficult to change the system. In this tradeoff, time is both knowledge and money.

The persuasion-versus-information-glut dilemma, on the other hand, is a special case of the standard common-pool resource social dilemma. Any party with an educational or persuasive interest will wish to broadcast its message in a public forum. Too many messages in an unregulated forum, however, may result in the public tuning out messages altogether. The scarce resource in this case is not information or knowledge, but attention.

'Mattera's Dilemma' (Smithson, 1989) is an example of a conundrum in social regulation that has both tradeoff and dilemmatic components. The tradeoff arises from the fact that a climate favouring creativity and entrepreneurship requires the toleration of uncertainty in the service of freedom. Insistence on full knowledge and control eliminates the latitude needed for creativity. The dilemmatic component arises from the fact that the greater the attempts to regulate behaviour, the more reactive people become and the more they attempt to generate uncertainty in the would-be controllers by withholding information or giving false information. If both parties pursue their self-interests, then the end result is a system of constraints and controls built on disinformation.

In closing, let us return to two popular metaphors mentioned earlier, both invoking the notion of knowledge as covering terrain, but with nearly opposite views on the progress of knowledge. In one metaphor, the border between the known and unknown is a wild frontier. Learning and discovery push back the frontier. The advance of knowledge diminishes uncertainty. In the other, the unknown is an ocean and knowledge is an island. As the island is made larger, the extent of the border between the known and unknown becomes larger as well. The advance of knowledge increases our awareness of what we do not know.

A third metaphor that captures the sense of a question-answer-question sequence in the process of inquiry could be called the 'dark room' metaphor. This metaphor is expressively used by the mathematician Andrew Wiles to liken the experience of doing mathematics (Singh, 1998, p258) to the exploration of a darkened mansion. There is a long period of stumbling around in the first room, bumping into things and gradually becoming familiar with every object in the room. Eventually the explorer finds the light switch and turns it on. Everything in that room is clearly visible now. But there is a door that leads into another dark room. And perhaps the mansion has infinitely many rooms.

NOTE

1 In 1994, a grove of trees of a species previously believed to have been extinct for 60 million years was discovered in the Wollemi National Park in New South Wales. To protect the grove, its location has been a closely guarded secret.

REFERENCES

Anderson, C. J. (2003) 'The psychology of doing nothing: Forms of decision avoidance result from reason and emotion', *Psychological Bulletin*, vol 129, pp139–167

Böschen, S. and Wehling, P. (2004) *Wissenschaft zwischen Folgenverantwortung und Nichtwissen*, Verlag für Sozialwissenschaften, Wiesbaden, Germany

Brown, J. D. (2004) 'Knowledge, uncertainty and physical geography: Towards the development of methodologies for questioning belief', *Transactions of the Institute of British Geographers*, vol 29, pp367–381

Burgoon, M., Callister, M. and Hunsaker, F. G. (1994) 'Patients who deceive', *Journal of Language and Social Psychology*, vol 13, pp443–468

Ellsberg, D. (1961) 'Risk, ambiguity and the Savage axioms', *Quarterly Journal of Economics*, vol 75, pp643–669

Fanos, J. H. and Johnson, J. P. (1995) 'Barriers to carrier testing for adult cystic fibrosis sibs: The importance of not knowing', *American Journal of Medical Genetics*, vol 59, pp85–91

Fukuyama, F. (1995) *Trust: The Social Virtues and the Creation of Prosperity*, Free Press, New York

Furedi, F. (2002) *Culture of Fear* (revised edition), Continuum, London

Horgan, J. (1996) *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*, Little, Brown and Co, London

Kerwin, A. (1993) 'None too solid: Medical ignorance', *Knowledge: Creation, Diffusion, Utilization*, vol 15, pp166–185
Knorr Cetina, K. (1999) *Epistemic Cultures: How the Sciences make Knowledge*, Harvard University Press, Cambridge, MA
Kramer, R. M. (1999) 'Trust and distrust in organizations: Emerging perspectives, enduring questions', *Annual Review of Psychology*, vol 50, pp569–598
Krause, P. and Clark, D. (1993) *Representing Uncertain Knowledge: An Artificial Intelligence Approach*, Intellect, Oxford
Lakoff, G. and Johnson, M. (1980) *Metaphors We Live By*, University of Chicago Press, Chicago, IL
Leiss, W. 'Searching for the public policy relevance of the risk amplification framework', in N. Pidgeon, R. E. Kasperson and P. Slovic (eds) *The Social Amplification of Risk*, Cambridge University Press, Cambridge
Merton, R. K. (1987) 'Three fragments from a sociologist's notebooks: Establishing the phenomenon, specified ignorance and strategic research materials', *Annual Review of Sociology*, vol 13, pp1–28
Michaels, D. and Monforton, C. (2005) 'Manufacturing uncertainty: Contested science and the protection of the public's health and environment', *American Journal of Public Health Supplement*, vol 95, ppS39–S48
Moore, W. E. and Tumin, M. M. (1949) 'Some social functions of ignorance', *American Sociological Review*, vol 14, pp787–795
Mortensen, C. D. and Ayers, C. M. (1997) *Miscommunication*, Sage, Thousand Oaks, CA
Proctor, R. N. (1995) *Cancer Wars: How Politics Shapes what we Know and Don't Know about Cancer*, Basic Books, New York
Rachlin, H. (1989) *Judgment, Decision and Choice*, Freeman. New York
Ravetz, J. (1993) 'The sin of science: Ignorance of ignorance', *Knowledge: Creation, Diffusion, Utilization*, vol 15, pp157–165
Singh, S. (1998) *Fermat's Last Theorem*, Fourth Estate, London
Smithson, M. (1985) 'Toward a social theory of ignorance', *Journal for the Theory of Social Behaviour*, vol 15, pp151–172
Smithson, M. (1989) *Ignorance and Uncertainty: Emerging Paradigms*, Springer Verlag, New York
Smithson, M. (1993) 'Ignorance and science: Dilemmas, perspectives and prospects', *Knowledge: Creation, Diffusion, Utilization*, vol 15, pp133–156
Smithson, M. (1999) 'Conflict aversion: Preference for ambiguity vs. conflict in sources and evidence', *Organizational Behavior and Human Decision Processes*, vol 79, pp179–198
Smithson, M. (in press) 'Social theories of ignorance', in R. N. Proctor and L. Schiebinger (eds) *Agnotology: The Cultural Production of Ignorance*, Stanford University Press, Stanford, CA
Tetlock, P. E. (2002) 'Social functionalist frameworks for judgment and choice: Intuitive politicians, theologians and prosecutors', *Psychological Review*, vol 109, pp451–471
Wilson, T. D., Centerbar, D. B., Gilbert, D. T. and Kermer, D. A. (2005) 'The pleasures of uncertainty: Prolonging positive moods in ways people do not anticipate', *Journal of Personality and Social Psychology*, vol 88, pp5–21