10. Introduction

In 2003, when Professor Aileen Plant went to Vietnam to head the World Health Organisation (WHO) response to a new mystery killer disease, she dived into a sea of unknowns.[1] *This was a disease that had no clear-cut clinical diagnosis and for which there was no test. The organism that caused it was unknown, as was its mode of transmission. It was not evident how long those with the illness were able to infect others or indeed what the outcome would be for those affected.*

Just as Plant arrived in Vietnam, the WHO gave the new disease a catchy but non-specific name: SARS—for 'severe acute respiratory syndrome'. Despite the unknowns, public health officials and the community had to act. For example, Plant had to advise on a range of issues for which there were no definitive answers, such as:

> *How often should the front counter in a bank be cleaned?*
>
> *Should a mother who has recovered from SARS breast-feed her child?*
>
> *When could people who have had SARS resume sexual activity?*
>
> *If a woman has SARS, should her husband be allowed to serve food in his restaurant?*
>
> *When is it safe to discharge people with SARS from hospital?*
>
> *When was a person with SARS first infectious to other people?*
>
> *Can people have SARS but no symptoms?*[2]

The requirement to act in the face of widespread unknowns applies not only to problems like SARS, but also to other complex social and environmental challenges such as organised crime, global climate change and population ageing.[3] There are two primary purposes in highlighting the importance of unknowns. One is to explain why actions taken to address complex real-world problems will inevitably be imperfect. As I explain later in this chapter, this is an unavoidable consequence of the characteristics of unknowns, especially that

1 Plant (2008).

2 Plant (2008, p. 48).

3 Key factors differentiating between problems are the prominence of the unknowns and the urgency for action. These are both extreme in cases like SARS, whereas for other issues there may not be as many unknowns and/or there can be an extended time to plan responses to deal with them.

they are unlimited while ability to investigate them is constrained. Furthermore responding effectively to such inescapable imperfection is difficult. Some reactions to be avoided are briefly described.

Finding appropriate ways to handle unknowns and imperfection leads to the second purpose. The ultimate goal of highlighting the importance of unknowns is to help policy makers and practitioners make the best possible decisions, which cannot be based on the available evidence alone. Ignoring unknowns can lead to misguided actions and unintended negative consequences, which can be catastrophic.[4] Of course, perfect decisions and actions are not possible, but taking unknowns into account aims to allow more realistic assessment of the adequacy of decisions, as well as better preparation for things that can go wrong. At this stage understanding about unknowns is not sophisticated enough for this goal to be achievable. Instead, the chapters for this domain lay out a broader conceptualisation of unknowns and responses to them to set the direction for future work.

At the end of this chapter, I provide additional background for this domain by describing various kinds of unknowns. Furthermore, the diversity of unknowns does not easily map onto the different perspectives of disciplines and stakeholders. Instead, those perspectives introduce further complexities and these are also briefly described.

In the remaining chapters in this section a more comprehensive approach to unknowns is explored systematically using the five-question framework, which for this domain becomes the following.

1. What is the understanding and management of diverse unknowns aiming to achieve and who is intended to benefit? (For what and for whom?)
2. Which unknowns are considered? (Which unknowns?)
3. How are diverse unknowns understood and managed, by whom and when? (How?)
4. What circumstances might influence the understanding and management of diverse unknowns? (Context?)
5. What is the result of understanding and managing diverse unknowns? (Outcome?)

4 Interventions that have unintended adverse consequences are common. For example, police action to reduce the visibility of illicit drug use in one geographical area can lead to displacement of the activity, more risky injecting practices and increased violence and fraud (Aitken et al. 2002). Fortunately, catastrophic events are scarcer, but examples include the marketing of thalidomide as a cure for morning sickness in the late 1950s and the reform of the Russian economy following the breakdown of the Soviet Union in the early 1990s.

As with the previous domain, each question is discussed in turn in order to flesh out the I2S structure and the broad categories of concepts and methods that are encompassed. This is summarised in Figure 10.1. (Let me reiterate that populating the structure with the full range of concepts, methods, case examples and guides to relevant knowledge from outside I2S is not the function of this book, but is the task of the I2S Development Drive. This involves not only collating what is already known and practised, but also considerable original investigation to enhance understanding about unknowns.) Chapter 16 concludes this section by describing how the three different kinds of specialisation in I2S deal with diverse unknowns in order to enhance the work of integrative applied research teams.

Before considering the five-question framework, let us examine the three background issues foreshadowed earlier: the inevitability and challenges of imperfection, appreciating different kinds of unknowns, and understanding where disciplines and stakeholders sit in relation to unknowns. The chapter then finishes by considering knowledge synthesis (Domain 1) and unknowns (Domain 2) together to examine where to draw the line between them.

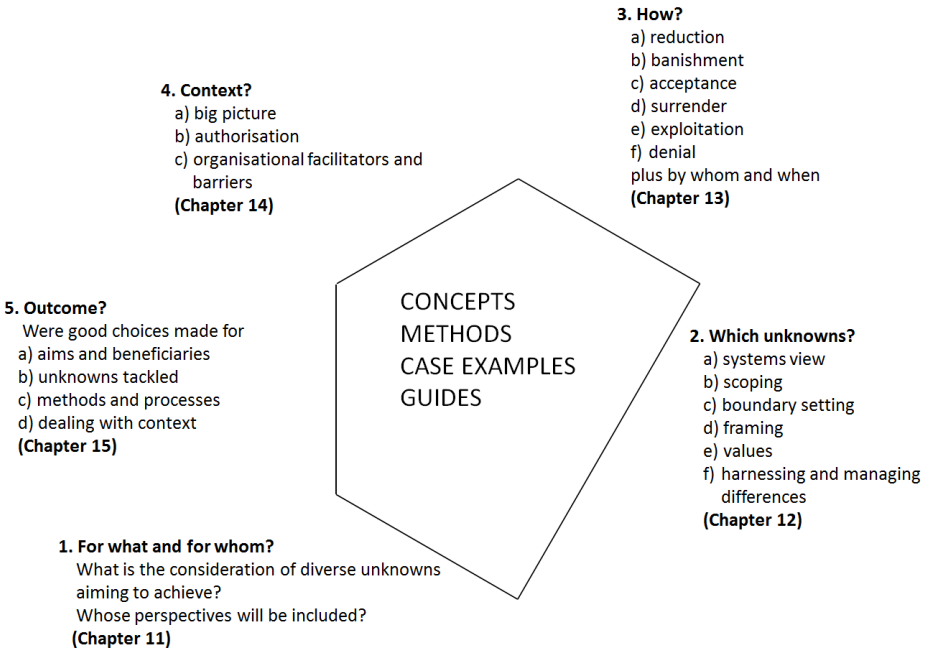

Figure 10.1 The Storeroom for Understanding and Managing Diverse Unknowns, Listing the Key Categories of Concepts and Methods

Source: Author's illustration.

The Inevitability and Challenges of Imperfection

Imperfection is inevitable when addressing the complex real-world problems central to integrative applied research. As described next, this arises because unknowns are unlimited (and some are unresolvable), while research capacity is constrained. The challenge then becomes how to craft an appropriate response to complex problems in light of this unavoidable clash. A first step is to highlight responses to be avoided.

Unlimited Unknowns and Constrained Research Capacity

There are at least four reasons why unknowns cannot be contained

1. change is constant, so new unknowns will continue to arise
2. research will always uncover new unknowns
3. some things are unknowable
4. techniques to research some unknowns have not yet been developed.

An example of constant change is that bacteria and viruses continually evolve to exploit human, animal and plant niches, inexorably leading to new diseases; however, it is not possible to predict what the next new disease will be or where or when it will strike. Similarly, human ingenuity will persist in inventing new technology with some innovations—like the Internet and the mobile phone—being revolutionary. But the next major breakthrough cannot be determined. Change is not only manifested in evolution and technology, but also in culture, and economic and social conditions.

Another source of change is the illumination of new unknowns through research, which warrants consideration in its own right. One demonstration of research uncovering novel unknowns is the common conclusion in research papers pointing to areas where more research is required. But research not only raises previously unasked questions to be addressed. Even the knowledge produced can increase unknowns by generating more, rather than fewer, conflicting views.[5]

The third source of unlimited unknowns is that some things are unknowable. Mathematics and quantum physics provide solid evidence for the irreducibility

5 Rayner (2006).

(or unknowability) of at least some unknowns.[6] It is likely that there are also irreducible unknowns in other areas, with current debates in both history and economics providing examples.[7]

Some unknowns may not be irreducible in principle, but are currently so in practice because available methods do not exist to address them adequately. This is the fourth source of unlimited unknowns. For example, there are ancient texts that cannot be translated.[8] Similarly, understanding illicit drug use is limited by many users keeping this behaviour secret and not participating in research. There are no reliable methods for identifying and accessing them.[9] While methodological breakthroughs will occur from time to time, new unsolvable problems will also continue to arise.

It is sobering to couple the unconstrained nature of unknowns with the fact that the capacity to undertake research is a limited resource.[10] Consequently, there can never be enough researchers or funding to study all the important problems existing at any one time. Furthermore, research effort is unevenly distributed on a global scale, with many more researchers in developed countries than in the industrially developing world.[11] Not surprisingly, this means that less research is conducted into the complex real-world problems of the latter countries.[12]

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6 In mathematics, Gödel and others in the 1930s established that no extensive mathematical system, such as arithmetic, can be both consistent and complete. Here 'consistency' means that the mathematical framework never generates paradoxes or contradictions and 'complete' means that every meaningful statement generated by the mathematical system can be proven true or false. Thus mathematics can never be freed of both paradoxes and undecidable propositions. (This idea was developed by Smithson, based on Nagel and Newman 1959, and described in Bammer et al. 2008.) In other words, developing a mathematical system that is consistent means that it will contain unknowns in terms of propositions that cannot be proven true or false. Similarly, developing a mathematical system that is complete means that it will contain unknowns in the form of paradoxes. For a more detailed discussion, see Smithson (1989). An analogous situation occurs in quantum physics, where the location and momentum (speed and direction of travel) of a subatomic particle cannot both be known with precision at the same time. Knowing the location means that momentum is unknown, and knowing momentum means that one has no idea where the particle actually is (Buckman 2008).

7 In history, some see certain historical knowledge as possible, or at least as limited only by shortcomings in the evidence, while others argue that since history is always written in the present, it will always bear the imprint of particular concerns and perspectives. In their view it will always require rewriting, as new questions from the present prompt new ways of reading and interpreting the historical evidence (Curthoys 2008). Similarly in economics: 'Discussion of problems involving uncertainty is polarized between advocates of formal decision theories, who claim that uncertainty can be tamed by careful consideration of information and elicitation of preferences, and critics who argue that uncertainty is fundamentally irreducible' (Quiggin 2008, p. 201).

8 This is also confounded by uncertainty about whether the texts are genuine; see, for example, Láng (2010) and news articles on the Voynich Manuscript and the Dorabella Code in *New Scientist* (21 May 2011, p. 44).

9 Ritter (2008).

10 For example, Lindblom (1990, p. 162) contended: 'Professional inquiry is a scarce resource even in a wealthy U.S., never abundant enough to permit study of all important social phenomena and problems, even if the entire adult population became social scientists.' This is true for researchers in general.

11 Examination of research capacity across low, lower-middle, upper-middle and high-income economies shows stark differences on a range of measures (Anderson and Bammer 2005).

12 The Global Forum for Health Research, for example, was established specifically to redress that imbalance in health research; see <http://www.globalforumhealth.org/> (accessed 20 December 2011).

Inappropriate Responses to Imperfection

It can be hard to acknowledge that there are no perfect ways forward for major real-world problems, and overconfidence that an answer exists is one response to be avoided. Steve Rayner highlighted that this is an issue for researchers in relation to policy making on environmental risk:[13]

> [P]olicy makers are consistently led to believe that, given time and money, scientific inquiry will reduce relevant uncertainty about environmental risk. Their scientific advisors hold out the promise that more fine-grained information will clarify the nature and extent of the problem and enable policy makers to craft efficient and effective responses.

Rayner then went on to point out why this is mistaken, based not only on the new areas research uncovers, but also on the often conflicting findings of different investigations (already mentioned above). An additional issue is that it may not be possible to even uncover all the unknowns. This may be a consequence of limited resources, but is also a feature of some unknowns (so-called 'unknown unknowns', discussed below).

In raising the unavoidability of imperfection, it is important not only to combat arrogance about certainty, but also to avoid falling into the opposite trap of hopelessness and nihilism. Some actions, even if imperfect, are much better than others. The successful containment of the SARS epidemic[14] showed that it is possible to manage effectively in the face of overwhelming unknowns. Taking no action would have been a great deal worse.

A different challenge associated with imperfection is hindsight bias, where actions are criticised based on information the decision makers did not have at the time. This is illustrated by the 2009 outbreak of the H1N1 (swine flu) virus, where the imposition of quarantine and other restrictions was criticised when the virus turned out to be less deadly than first thought.[15]

A further challenge raised by the need to find ways of accepting and managing imperfection is to avoid providing hiding places for incompetence or corruption. Here the impossibility of obtaining a full picture of a situation may be offered as an excuse for not taking sensible action or for taking action that is self-serving rather than directed at the problem. An example of incompetence is where irrelevant information is used to justify a decision because that is all that is available, such as when cost–benefit analysis is used even though most of the relevant costs and benefits cannot be expressed in dollar values. Corruption can

13 Rayner (2006, p. 5).
14 Plant (2008).
15 See, for example, Fineberg (2011).

be illustrated by the casting of doubt to stymie action based on solid evidence, as occurred when the tobacco industry sought to question the link between smoking and lung cancer.[16]

Appreciating Different Kinds of Unknowns

Two ways of describing unknowns are presented to provide insight into their diverse range. The first is a broad characterisation of three kinds of unknowns. The second is a more detailed taxonomy. Understanding the different kinds of unknowns is a critical step in developing more suitable and comprehensive ways of responding to them.[17]

Three Kinds of Unknowns

The matrix presented in Figure 10.2 is a useful—and increasingly acknowledged—way of distinguishing unknowns.

		META-LEVEL	
		Known	***Unknown***
PRIMARY LEVEL	***Known***	Known knowns	Known unknowns (conscious ignorance)
	Unknown	Unknown knowns (tacit knowledge)	Unknown unknowns (meta-ignorance)

Figure 10.2 Distinguishing Different Kinds of Unknowns

Source: Adaptation by Michael Smithson of Kerwin (1993), published in Bammer et al. (2008, p. 293).

Of the three kinds of unknowns, the most familiar is ignorance that we are aware of: the 'known unknowns'. For example, we know that we do not know how much genes contribute to criminal behaviour or how to accurately predict long-range weather. Most research addresses this kind of ignorance, seeking to fill in known knowledge gaps.

Another kind of unknown is knowledge that we do not know we have, the 'unknown knowns' or 'tacit knowledge'. Becoming a disciplinary expert involves being socialised into particular ways of thinking and operating, some of which

16 Littlemore (2010).

17 Bammer and Smithson (2008); Bammer and The Goolabri Group (2007); Smithson (2008a). Smithson also points out this topic does not have an agreed nomenclature. In earlier work we used the term 'uncertainty'; for this book I use 'unknowns'.

are explicit and some of which are tacit.[18] Culturally appropriate behaviours are another example of tacit knowledge. These include body language, how people address each other, how conversations are conducted and what is considered to be polite.[19]

The third kind of ignorance is what we do not know we do not know: the 'unknown unknowns'.[20] This can be a difficult concept both to understand and to do something about. We generally become aware of unknown unknowns in two ways. Some unknown unknowns catch everyone by surprise and the only way we can become aware of those is through hindsight. For example, before 2003, SARS was an unknown unknown—we did not know that such a disease was developing and would strike. But other unknown unknowns are specific to individuals or communities, so that people can see them in each other and alert each other to them. I might, for example, believe that there is only one kind of rice. A Pakistani colleague or a good cook could quickly disabuse me of that. Such blind spots can also occur on a much larger scale. For example, when the US Government was planning the 2003 invasion of Iraq, promotion of democracy was part of its rationale. The US officials could not see that they were conflating democracy with 'Americanisation' and it took UK Government officials to point this out to them.[21]

Let us move on now to a categorisation of unknowns that teases out much finer-grained differences.

A Taxonomy of Unknowns

Figure 10.3 presents a taxonomy developed by Smithson, who uses the overarching term 'ignorance' as the starting point. He first distinguishes between passive and active ignorance. Passive ignorance involves areas that we are ignorant of, whereas active ignorance refers to areas we ignore. He uses the term 'error' for the unknowns encompassed by passive ignorance and 'irrelevance' for active ignorance.

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18 When I was a biochemistry honours student, for example, I explicitly learnt various biochemical theories and facts, and had good laboratory processes instilled more tacitly. Laboratory-based research requires attention to possible contaminants, so that processes were inculcated to minimise this risk using specific ways of washing and drying glassware, cleanliness and avoidance of clutter on benchtops, required behaviours, such as wearing protective clothing, and unacceptable behaviours such as horseplay. Appropriate procedures became second nature and were usually intuitively applied when new situations arose.

19 O'Sullivan (1994).

20 These unknowns gained some notoriety when former US Secretary of Defence Donald Rumsfeld made remarks about them to US troops in Korea on 18 November 2003. See <http://www.iwar.org.uk/news-archive/2003/11-21-9.htm> (accessed 21 December 2011).

21 Campbell and Scott (2008).

The different elements of the taxonomy are explained in Box 10.1. The main point here is to demonstrate that there are multiple kinds of unknowns, many, if not all, of which will be inherent in any complex problem.

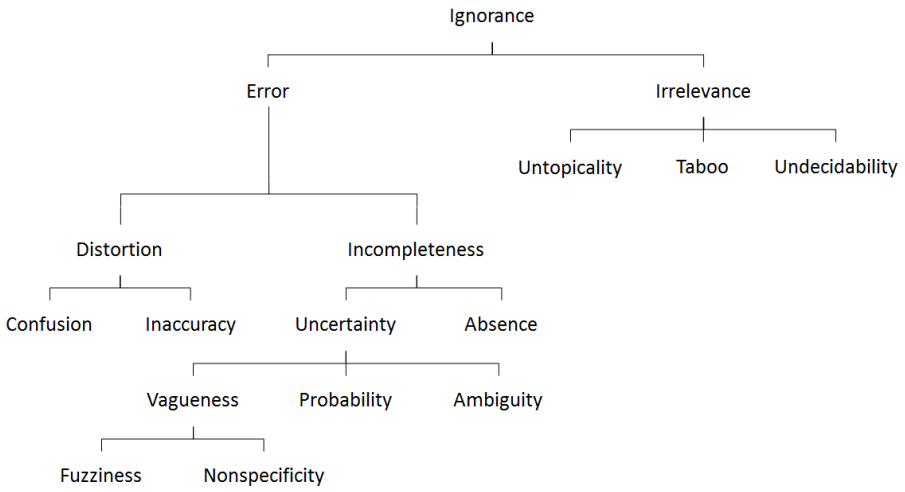

Figure 10.3 Different Kinds of Unknowns

Source: Smithson (1989, p. 9); also in Bammer et al. (2008, p. 294).

Box 10.1 An Explanation of Smithson's Typology

Having differentiated passive (error) from active (irrelevance) ignorance, let us examine the types of unknowns under 'error'. Smithson distinguishes two sources of error: 'distortion' and 'incompleteness'. One type of distortion, 'confusion', involves wrongful substitution—mistaking one attribute for another. Mistaking a block of cheese for a bar of soap is an example of confusion. The other, 'inaccuracy', is distortion in degree or bias. Assuming that all swans are white is an example of inaccuracy.

In terms of 'incompleteness', Smithson first differentiates between what he calls 'incompleteness in degree' or 'uncertainty', and 'incompleteness in kind' or 'absence'. Let us deal with absence first. Absence is simply gaps in knowledge, which can be known or unknown gaps.

If we turn now to 'uncertainty', Smithson's taxonomy uses this term to refer to partial information. He subdivides uncertainty into three categories: 'vagueness', 'probability' and 'ambiguity'. In brief, vagueness relates to a range of possible values on a continuum; probability, simply put, refers to the laws of chance; and ambiguity refers to a finite number of distinct possibilities. In expanding on these, let us begin with vagueness.

Smithson subdivides vagueness into 'fuzziness' and 'non-specificity'. Fuzziness refers to fine-grade distinctions and blurry boundaries. For example, an object may be dark, but there is no clear boundary where darkness begins and ends. Non-specificity is another kind of vagueness. An example relates to geographical location. To say that someone lives *near* a school does not give any indication of whether they are a five-minute walk away or a five-minute drive away.

Moving on to probability, the classic example refers to numerous tosses of a fair coin and the likely outcome that half of the tosses will land heads and half tails. It is worth noting, however, that despite the pervasiveness of probability and its underpinning of the discipline of statistics, the concept is by no means well defined, so that there is considerable work to be done to address the question 'What sorts of things are probabilities?'.[a] In reality, much statistics involves tackling problems that combine vagueness and probability. While probability does not help us with the vague statements provided as illustrations in the previous paragraph, it can assist with other vague statements, such as 'this ticket may win money in the lottery' or 'today some drivers will be injured in an accident'. Probability then helps us calculate the chance of winning or being injured.

The final item in the 'error' side of the taxonomy is 'ambiguity', which is best demonstrated though a linguistic example. To say that food is hot does not clearly tell us if this refers to temperature or spiciness. In terms of disciplines, ambiguity is prominent in the law, where nuances of interpretation can be critical.[b]

Let us now move to the second main arm in the taxonomy (Figure 10.3). 'Irrelevance' refers to issues that are deliberately or unconsciously overlooked. Smithson divides irrelevance into three subcategories—namely 'untopicality', 'taboo' and 'undecidability'.

For the first of these, in the consideration of any particular issue, some things will be generally agreed to be off topic. In defence policy decisions, for example, the price of children's toys would generally not be considered topical.

In terms of taboo, this refers to matters people must not know or even inquire about. This is socially enforced irrelevance. Taboo is important in the discipline of history, for example. The attempt to open up some issues—such as the Holocaust, the nuclear bombing of Japan in World War II or the demise of Australian Aborigines—to further examination can be highly controversial. Curthoys[c] has highlighted the conflict that can ensue when national audiences 'want a story that reassures them about the morality of the national past' but also want the truth, which may be that 'the national past may not be entirely or even mainly praiseworthy'.

The final kind of irrelevance is undecidability, which happens when a matter cannot be designated true or false or when deciding on truth/falsity is not pertinent. The first kind of undecidability overlaps with our earlier considerations of 'irreducability'. We have seen that there are truly undecidable matters in both physics and mathematics.

The second kind of undecidability is where the issues of truth and falsehood are largely irrelevant. The law provides an example in that it 'specifically acknowledges that, in the courtroom context, progress to a decision occurs on the basis of finding facts for the purpose of the court's decision—with only coincidental regard for objective "truth"'.[d] In other words, a 'fact' for legal purposes may not be as tightly defined as a scientific fact.

a. Hájek (2008).
b. Jones (2008).
c. Curthoys (2008, p. 134).
d. Jones (2008, p. 275).

Understanding Where Disciplines and Stakeholders Sit in Relation to Unknowns

Let us begin with disciplines and three important considerations, namely: a) different kinds of unknowns do not clearly map onto existing disciplines, b) no discipline covers more than a fraction of the terrain, and c) disciplines raise additional considerations about unknowns that cannot be covered by taxonomies. I only provide a flavour of these considerations here—the detailed work required is part of the I2S Development Drive.

First, if we look at the unknowns covered in the discipline of history[22] and Smithson's typology, we see that there is no neat overlap. What history deals with includes

- absence, which occurs when records are missing
- inaccuracy, which arises when it is not clear how representative the records are for a particular period—for example, the rich are more likely to leave records than the poor, but even those records may not be typical of all rich people at that time
- taboo, which ensues when some historical events are closed to scrutiny; this was described in Box 10.1 in relation to the conflict between the desire of national audiences for a version of events that fits a favourable national self-image and what really happened, which may not be at all admirable.

Further, even though history contends with each of these aspects of unknowns, it is not the only relevant discipline for any of them, nor does it, by itself,

22 Curthoys (2008).

provide a comprehensive understanding of any of these unknowns. Any correspondence is only partial. If we take inaccuracy, for example, psychology also has a lot to contribute, particularly in terms of different kinds of cognitive bias that are inherent in processing information and making decisions.[23]

Second, even though dealing with the unknown is the 'bread and butter'[24] of statistics, this discipline covers only a small part of the terrain. Taking Smithson's typology, the discipline of statistics primarily operates in the area of incompleteness, across probability and some kinds of vagueness.[25] In terms of its considerations of sampling bias, statistics also has some overlap with inaccuracy. But, as the typology shows, there is much more to unknowns than the areas statistics deals with. We can take this description of limited coverage further by examining the value of statistics to history. We can see that statistics is of no use for issues of absence or taboo. Even in the area of inaccuracy where history's problem of representativeness can be thought of as a case of sampling bias, statistics cannot help with many of the problems history deals with, such as understanding bygone customs from an unrepresentative assortment of written records and artefacts.

Finally, various disciplines raise additional considerations that are not encompassed by assorted forms of classification, but that are important when tackling complex real-world problems. Let us take some of the insights that psychology provides as an example. One is that unknowns have a normative dimension. A well-adjusted person is often thought of as a 'knowledge seeker' who can tolerate uncertainty, is open to novel experience and is not defensive about prior beliefs. This contrasts with someone with an authoritarian personality, who has the opposite attributes.[26] These different orientations to even considering unknowns can be critical when forming research teams, in interactions with stakeholders and when presenting research results to policy makers and practitioners. Psychology also provides insights into the debilitating consequences of uncertainty, unpredictability and uncontrollability,[27] which may be very important when involving the general public in trying to understand complex real-world problems.[28]

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23 See, for example, Nickerson (1998); Tversky and Kahneman (1974).

24 Attewell (2008, p. 81).

25 As illustrated in Box 10.1, statistics is useful for some types of vagueness, but not others.

26 Smithson (2008b).

27 Smithson (2008b).

28 Smithson has also highlighted that unknowns can be beneficial as well as detrimental, at both individual and society-wide levels. For example, a climate favouring innovation and entrepreneurship requires tolerating some unknowns, including risks. While it can be relatively easy to understand the importance of unknowns in stimulating the creative process, including in science and art (Grishin 2008 has shown how artists from Leonardo da Vinci to the surrealists drew on unknowns), less immediately obvious is Smithson's analysis that freedom of choice relies on unknowns and can be thought of as 'positively badged uncertainty'—for example, see his blog 'Can we make "good" decisions under ignorance?' (<http://ignoranceanduncertainty.wordpress.com/tag/knowledge-management/>, accessed 22 December 2011); and Smithson (1989).

A lesson—which I hope is obvious from this discussion so far—is that bringing together different disciplines is as essential for developing a rich understanding of unknowns as it is for developing a comprehensive picture of what is known.

What about stakeholder perspectives on unknowns? First, there may be unrecognised similarities between disciplines and stakeholders in the unknowns they deal with and there may be great benefit from combining forces. For example, there are overlaps between the concerns of the historian and those of the intelligence analyst. In particular, each deals with circumstances where information is limited and its veracity unknown. I have already described this in the case of history where deductions about the past have to be made on the basis of, often very few, records, which may be quite biased. Similarly, intelligence can require investigation of clandestine activities by using undercover operatives, who may be restricted in their capacity to access key documents or to be present at critical meetings.[29]

Second, respectfully listening to the concerns of stakeholders can make researchers aware of a range of unknowns that are not covered by standard discipline-based approaches. The challenge is to use these concerns to enrich thinking about unknowns, rather than ruling them out as irrelevant because tools to understand and respond to them are limited. Such broadening of considerations about unknowns occurred in the research on the feasibility of diamorphine prescription through our interactions with a wide range of stakeholders, although we did not appreciate it in these terms at the time. We set out to uncover the full gamut of concerns about a trial and, as a result, inevitably ended up recognising diverse unknowns. This was not planned, but was an unintended consequence of our overarching interest in being thorough in our investigation and in taking into account the variety of stakeholder perspectives about a trial. In addition, because we tried to deal with each unknown openly and honestly, we soon stumbled across the inevitability of imperfection, in particular that there was no way a trial could be risk-free.[30]

Furthermore, just as disciplines can raise additional considerations about unknowns, so too can stakeholders. Let us take just two examples. One comes from religion, where, as Pickard describes, faith and personal doubt need not be fundamental opposites, but can reinforce each other most fruitfully. Having faith need not therefore mean the abdication of reason.[31] The second comes from jazz, which turns our understanding of tactic knowledge on its head. Usually tacit knowledge is thought of as something that needs to be made explicit to enhance

29 Longford (2008). In other circumstances, both can experience the opposite problem—in other words, having too much information to deal with. In history this can occur when examining the records of a recent government and in intelligence when monitoring phone records.

30 Bammer (1999); Bammer et al. (1999).

31 Pickard (2008); Ravetz (2008).

understanding of differences between people. But becoming a successful jazz musician involves reversing this process—that is, making known knowledge tacit. As John Mackey points out, learning to improvise requires internalising a wide range of musical knowledge, so that it can be called on without conscious consideration when the time comes to 'take a solo'.[32] Similar thinking lies behind training people in how to respond in emergencies. Even something as simple as a fire drill involves practising what to do, so that the response can be automatic when a real emergency occurs.

Differentiating the First and Second Domains

Before concluding this chapter, let us examine the distinguishing features of the first and second domains when it comes to unknowns. A useful starting point is the research I directed into the feasibility of diamorphine prescription to treat heroin dependence. On the one hand, we undertook a lot of standard discipline-based research—for example, we reviewed the literature, examined the United Nations conventions, surveyed the police and general community[33] and used demographic methods to estimate the number of heroin users,[34] all of which I would include under knowledge synthesis.

On the other hand, we also took into account important unknowns that cannot be easily addressed through standard disciplinary processes. For example, we investigated whether Canberra might become a 'honey pot' attracting heroin users from other parts of Australia,[35] what the impact might be on drug markets[36] and whether being in a trial might further marginalise participants.[37] There were no straightforward, well-accepted methodologies for addressing any of these questions.[38]

A simple differentiation is that the first domain deals with unknowns in a 'business as usual' way, whereas the second domain aims to help figure out which other unknowns may be critical and how to respond to them. The point of this second domain is, therefore, to ensure that much wider and more intensive attention is paid to unknowns than would traditionally be the case. The aim is to find new ways of thinking about unknowns that can help ensure that all the key unknowns in a problem are considered.

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32 Mackey (2008).

33 These are all described in Volume 2 of *Feasibility Research into the Controlled Availability of Opioids* (1991): see <http://nceph.anu.edu.au/files/intranet_page/214/stage1vol2a.pdf> or <https://digitalcollections.anu.edu.au/bitstream/1885/41235/2/stage1vol2a.pdf> (accessed 23 July 2012).

34 Larson (1992).

35 Bammer et al. (1994).

36 Bammer and Sengoz (1994).

37 McDonald et al. (1994).

38 Now various modelling techniques could be used to address these questions, but they were not widely used at the time of that research.

This text is taken from *Disciplining Interdisciplinarity: Integration and Implementation Sciences for Researching Complex Real-World Problems*, by Gabriele Bammer, published 2013 by ANU E Press, The Australian National University, Canberra, Australia.