Risk and rationality: the "frame problem" revisited, from the laboratory to the public sphere

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Introduction

Risk is increasingly central to a variety of academic disciplines and spheres of public and political life – it is arguably the main lens through which scientists, policy-makers, and publics characterise and debate environmental and public health problems ranging from climate change to food security to biodiversity loss. The field of risk research has long been concerned with how experts and laypeople evaluate environmental dangers and potential responses; the role of value judgments, interests, and moral commitments in this; and how lay knowledge, expertise, stakeholder interests and ethical arguments should be drawn upon to make decisions within particular institutional arrangements. However, the literature is widely dispersed, and marked by a healthy pluralism regarding foundational assumptions and analytical frameworks. As such, there is a pressing need to synthesize this fragmented knowledge, reflect on the major theoretical debates, and speculate on future research trajectories. This section is an attempt to do so. The contributed chapters are all broadly talking about the same thing - public understanding and the governance of environmental risks - although they are rooted in quite different philosophical and methodological heritages. Arvai et al.'s paper is very much in the tradition of the formal decision sciences; Macnaghten's work is rooted in European thinking within Science and Technology Studies; whilst Renn attempts to integrate a variety of disciplinary perspectives on risk, albeit with an emphasis on macro-level social theory. As such, distinctions and commonalities abound, roughly in equal measure. Rather than review the individual contributions - the chapters speak for themselves - this paper focuses on some of those common themes and disjunctures. In doing so we forward various claims of our own, which are primarily intended to be provocative rather than definitive.

The remainder of the paper proceeds as follows. We first provide a schematic outline of the evolution of Beck and Giddens' "risk society," before connecting this relatively abstract account with more empirically grounded analyses of lay discourses about risk, technology and innovation. Drawing in particular on Macnaghten's field work, we reflect on whether the notion of moral autonomy has anything to add to social theories of risk, particularly in relation to public alienation and (dis)engagement, and with regard to the apparent reemergence of fate as an organising concept in public discourse about risk issues. We then turn to consider whether a "risk framing" can act to close-

down the characterisation of environmental problems in ways that are both reductive and exclusionary to public engagement, drawing on Andy Stirling and Brian Wynne's ideas. Such an argument is explicit in Macnaghten's contribution, perhaps implicit in Renn's chapter and his previous work, while Arvai et al. seemingly either reject it or are agnostic. We then explore questions surrounding the realism and generalisability of those laboratory experiments which make up such a large portion of the decision sciences, reviewed by Arvai et al. We draw a contrast between the theoretical commitments of decision scientists and those evolutionary psychologists who focus on risk and uncertainty - most notable among them Gerd Gigerenzer - and discuss how this shapes their contrasting approaches to experimental design and how they interpret empirical data. We note that transportability or external validity is not a problem restricted to laboratory findings, and that claims about the broader relevance of empirical findings turn on the specifics of the research design (rather than whether it was conducted in the field or the laboratory), and on the cogency of the theoretical arguments used to justify any generalisation. Context - that slippery, ill-defined, yet crucial concept - is central to understanding the psychology of risk, and can *in principle* be explored and manipulated in the laboratory as well as in the field. We suggest that the study of decision making under uncertainty has become rather disconnected from the rest of cognitive psychology. In particular, the notion that conscious thought may play a substantive role in shaping how people reason about risk appears to have dropped out of the thinking of the decision sciences. We turn to critique the commonly rehearsed argument that decision-theoretic approaches to inference and choice are only applicable to a relatively restricted subset of decision contexts (the "small worlds" argument). Idealising assumptions can transform large worlds into small worlds, allowing the deployment of the full Bayesian apparatus. We then reflect on the paradox that a (skewed) interpretation of the findings of the decision sciences has travelled so easily into some institutional risk management and governance practices (the "cognitive miser"), despite long standing concerns about its external validity. The deficit model is dead; long live the deficit model! Variations on the "frame problem" structure our discussion throughout the paper. A brief conclusion follows.

The risk society and public (dis)engagement: alienation, or the abdication of moral autonomy?

Renn and Macnaghten's chapters draw heavily upon the idea of the broken promises of the Enlightenment's modernist narrative. This storyline positioned humans as no longer being at the mercy of fate, but rather as purposefully navigating their way through possible futures, harnessing the relentless growth of science and technology to tame and exploit nature in pursuit of social and economic progress (Leiss, 1974; Giddens, 1990). This had begun to look like a rather utopian idea by the

mid-20th century, which marked the growing recognition of the variety of ways that humans – via technology – were degrading the natural environment (Beck, 1992). Whilst in the past, people worried primarily about the risks *of* nature – from bad harvests, floods, plagues or famines - by this point they had begun to worry more about the risks that they posed *to* nature (Giddens, 2011). This widespread concern led to the repair program of the "regulatory state," characterised by risk management institutions that focussed on individual risk objects or technologies within specific jurisdictions, whilst paying limited attention to tradeoffs or interactions across domains, places, or scales (Sunstein, 1990; Wiener and Graham, 2009). However, the tenability of the repair program was challenged by the emergence of a new category of (global) risks. Their causes and consequences were not limited to a particular location or place; they were of our own making, yet also paradoxically it was unclear whose responsibility they were; and they were deeply challenging to calculate, given their unprecedented nature and lack of time series data (Beck, 1992). These new kinds of threats, combined with a series of high-profile failures of risk regulation across Europe and the US in the late 20th Century - from thalidomide to Bovine spongiform encephalopathy (BSE) - lead to a very public questioning of the Enlightenment view that technological development was synonymous with social, economic, and human progress, and skepticism about the capacity of the regulatory state to handle the tasks that it was designed for. The hubristic vision of the mastery of nature, of mankind as the author of his own destiny, began to rupture in the face of a sense of submission to a set of global economic, technological and cultural forces that are beyond full comprehension, and that seemed to almost possess an agency of their own. Rather than becoming more knowable and manageable, the near future was beginning to look more stochastic and nonlinear, generating a deep uncertainty that eroded any basis for rational planning and action (Reith, 2004). Or at least, this is the schematic account most closely associated with Beck and Giddens, which in common with much of continental social theory has been almost entirely untethered to empirical inquiry.

What is particularly interesting about Macnaghten's contribution is that it reviews empirical work that shows some of these abstract themes to be prevalent in the everyday discourse of laypeople, albeit in more nuanced and perhaps less dystopian forms. His public engagement research does not reveal negative attitudes towards science or innovation per se, but rather skepticism of the capacity of innovation under real-world conditions, and current institutions of governance, to overcome both foreseen and unforeseen harms, alongside a pervasive sense of fatalism and impotence. For example, one widespread public narrative frames emerging technologies such as agricultural biotechnology and nanotechnology as having their own internal dynamics and logics that influence society in ways that are

largely beyond cultural or even political influence. This is connected with a sense of public alienation, in the sense of a feeling of exclusion from the governance of processes of research and technological development. Together, this leaves the public dependent on the "expert systems" responsible for the development and governance of "techno-visionary" science and innovation (governments, regulators, scientists, corporate research and development and media), alongside a feeling that they are deeply powerless over their conduct, together with a suspicion that those institutions may not be up to the task.

However, this appears to be a feature not just of public understanding and engagement with "techno-visionary" science and innovation. For example, whether in focus groups, surveys, or interviews, laypeople frequently invoke industry, economic systems, or political institutions as the drivers of climate change, and, by large margins, place responsibility for tackling it firmly at the feet of government or politicians (e.g. Hinchliffe, 1996; Stoll-Kleemann et al., 2001; Spence et al., 2010; Lorenzoni et al., 2007; Wolf and Moser, 2011). And a close look at how people make sense of and talk about climate change reveals very little ascription of responsibility, or even references to, their own choices, behaviours, and actions, except to point out the futility or impossibility of changing them (e.g. McDaniels et al., 1996; Phillips, 2000; Bickerstaff et al., 2008). This suggests that people feel entrapped or locked-in to a broader set of social and economic structures. In short, they talk as though they have abdicated their moral and practical autonomy to external systems and institutions, leaving them little reason or incentive to adopt sustainable behaviours, and perhaps even little justification to believe that they ever can. Giddens (1990) has implied that this reflects a kind of psychological prop or coping mechanism to counter the anxieties of modernity, aimed at relieving the individual of the burden of engaging with existential threats that may otherwise prove chronically disturbing or destabilizing (c.f. Macnaghten, 2003). However, this abdication of autonomy is a particular problem given that many modern technological hazards or risk sources (*e.g.* carbon emissions) are so intertwined within the fabric of day-to-day social, industrial, and economic life, that the distinction between risk producers and risk bearers is rarely clear-cut.

Macnaghten asks in his contribution why such narratives have emerged at this particular juncture in history, and suggests that it stems in part from the exclusion of the public from formal processes of technological appraisal and risk governance. That is, he sees it as a counter-narrative or response to the institutional logics that emphasise the inevitability of technological progress and of the associated gains. Arvai et al. and the decision science tradition more broadly tend to conceive of public (dis)engagement with environmental problems in terms of psychological distance and framing effects.

On the surface this is quite different from the social theory and Science and Technology Studies perspectives, however slightly less formal notions of framing have been used to similar effect within these traditions. For example, Hulme (2010) argued that by constructing climate change as a global, techno-scientific problem driven by abstract systems (consumption, capitalism, demographics, etc.), elites, the media, and governance institutions have made it easy for laypeople to voice superficial concerns about the issue, resting alongside relatively little enthusiasm for concrete action or change. In other words, this construction has shifted perceptions of agency and autonomy for tackling climate change away from local places and people, locating them instead within abstract systems and formal institutions (MacGillivray, 2015). On this analysis, the value-action gap on climate change and related global sustainability crises - and the widespread public sense of apathy and resignation - is in part a framing problem.

Following this line of argument, the core concern becomes how to introduce a sense of meaningful agency and public engagement within processes of innovation and risk governance, a task that each contributing author addresses in slightly different ways. Macnaghten advocates upstream engagement as a core component of responsible innovation, and in particular the value of focus groups and other deliberative forums in getting a better sense of the social and ethical implications of technologies at a point early enough to shape or restrict their development. One of us has recently reflected on the philosophical and methodological challenges associated with this (Pidgeon et al., forthcoming). Renn's chapter, on the other hand, is favourable to Habermas' concepts of communicative action and communicative competence as a way of enhancing the legitimacy of risk management institutions, and makes a strong case for the International Risk Governance Council's framework, which he has been heavily involved in developing. However, he is pessimistic about the capacity of the public to engage in technical deliberation on risk issues, on the grounds that they lack the infrastructure of modern scientific institutions. This idea - that in a society with a sharp division of knowledge most truth-claims will remain opaque, meaning that the public must rely on judgements about the trustworthiness of experts and institutions rather than verify claims for themselves - appears to be as old as the ancient Greeks, seemingly inspiring Aristotle's work on rhetoric (O'neill, 2002). However, whilst it is true that the person on the street may lack the capacity to implement laboratory or field experiments on the benefits and harms of GM crops or nanotechnology, this does not prevent them from scrutinising the design and governance of such experiments, the assumptions that underlie them, and the chains of inference in moving from field or laboratory observations to determinations of risk and benefit (*e.g.* see Pidgeon et al., 2013). Arvai et al. are concerned more with decision support, that is, with structuring and framing

decision-making environments such that individuals and groups can make choices that are consistent with their values. An interesting distinction between the three chapters is that whilst Renn and Arvai et al.'s analyses are thoroughly rooted within the field of risk research, Macnaghten expresses a concern that framing processes of innovation and technological development as "risk" problems is unnecessarily reductive. We turn to this below.

Is a risk framing synonymous with "closing-down" the governance of environmental problems and processes of technological innovation?

One of us recently forwarded the argument that risk-based approaches are one of a small set of archetypes for governing environmental and public health problems, together with precautionary, adaptive, and deliberative regime types (MacGillivray and Richards, 2015). These types each hold distinct norms about what constitutes valid evidence, how evidence should be used, and what constitutes the proper ethical framework for decision-making (*e.g.* means-ends *vs.* communicative rationality). This built on previous work of Renn and colleagues, who developed various typologies of the "risk issues" faced by contemporary societies, setting out how each category of problems lends itself to particular analytical methods (*e.g.* Klinke and Renn, 2002 and Pellizzoni, 2001). For example, routine, well characterised problems are thought to lend themselves to the methods of probabilistic risk analysis, whereas contested, ambiguous issues require more participatory methods such as scenario planning to explore them. We extended this idea by claiming that problem characteristics and types of governance are co-produced (c.f. Jasanoff, 2004). What we argued is that the risk-based type, for example, does not simply lend itself to problems that are well-structured, largely technical, and mathematically tractable. Instead, it also constructs problems as holding the aforementioned characteristics, through the particular ontologies, frames, methods, and types of evidence that it draws upon or applies (Shackley et al., 1996 and Clifford and Richards, 2005).

Scholars from within the STS tradition - in particular Wynne (1992), Jasanoff (1993), Stirling (2008), and Macnaghten (this section) - have long voiced similar concerns, namely that the institutional dominance of the risk-based logic privileges particular kinds of analytical frameworks, evidence, societal goals, and approaches to public (non)participation that are reductive and technocratic. In his chapter, Macnaghten argues that "public engagement research with risk is rarely simply about risk as defined by institutional science. It is also about innovation, about the kinds of society we value and wish science and innovation processes to collectively contribute towards; it is also about control, about who will take responsibility if things go wrong." This leads to a normative agenda that conceives of governing techno-

visionary science and innovation not as a risk issue, but as a public issue with a technical dimension, and by extension prescribes extensive upstream engagement, deliberation on deep values, and discussion of the kinds of futures and societies that we want to produce. Yet in practice what we often see is a perpetual tendency on the part of regulatory institutions to restructure ill-defined, contested problems of innovation and technological development - deeply implicated in issues of what kind of futures, fundamental values, and identities we want to create - into neatly defined and compartmentalised technical problems of risk (Wynne, 2006; Stirling, 2008; MacGillivray and Franklin, 2015). Institutional practices of public engagement often remain rather superficial, for example taking place following the technical analysis (leaving little space for public scrutiny or participation), and reflecting attempts to manage or dampen controversy rather than secure meaningful public input (Wynne, 2006; Stirling, 2008; Lane et al., 2011). Macnaghten is also critical of some public engagement research for uncritically adopting dominant policy frames and institutional concerns, in ways that close-down the opportunity for eliciting deep values, conversations about the social meaning of technologies, and discussions of the desired trajectories of innovation rather than the details of particular risk objects (see also Pidgeon et al., forthcoming; Bellamy and Lezaun, 2015).

Renn's current chapter adopts a slightly different stance, seemingly viewing risk as an organising concept that is open to a plural mix of analytical techniques, modes of participation, and governance. Perhaps the distinction stems from Macnaghten's focus on institutional logics of risk as they exist in the world, whereas Renn orientation is more theoretical. Moreover, whether this is a substantive distinction or a semantic one is unclear. For example, consistent with his earlier work, Renn's chapter emphasises that the proper approach to risk governance - in terms of the analytical tools, decision making goals, and modes of participation - is a function of whether a problem should be characterised as simple, complex, uncertain, or ambiguous. This seems coherent with Macnaghten's stance. However, if all forms of analysis, deliberation, decision-making and governance can be bracketed under the risk concept, does the latter begin to lose its theoretical purchase? For example, integrative approaches such as the social amplification of risk framework (SARF) - which Renn co-developed and discusses at length - have been critiqued for reflecting a category error of sorts, that of attempting to synthesize concepts and theoretical frameworks that are ontologically in conflict (Duckett and Busby, 2013). However, this critique perhaps stems from a (mis)perception that SARF seeks to offer a coherent theory of the evolution of risk crises, as opposed to a heuristic framework for organising empirical inquiries across plural disciplinary perspectives (Kasperson et al., 2003).

Arvai *et al.*, on the other hand, are sensitive to the limits of decision-theoretic approaches as applied to real-world problems, but do not focus much on governance per se. However, they are very concerned with framing and the related issue of the construction of preferences, which has some structural parallels with the concept of closing-down. They write at length on how differences in the ways that structurally identical problems are framed or presented can influence people's judgments and preferences. However, whilst Macnaghten and his fellow travellers take these ideas to imply the importance of using open-frames in eliciting public views, values, and deliberations on emerging technologies, Arvai et al. are primarily interested in how the decision making environment of everyday life can be reframed to help people make decisions that are consistent with their values. More on this below.

Risk perception research: realism, the rationality wars, and the recalcitrance of the deficit model

Arvai *et. al.* and Macnaghten's chapters draw heavily on the findings of empirical research, although the underlying methodologies and epistemologies are quite different. Amongst the core design features of Macnaghten's research program are an orientation towards context and situated reasoning, drawing on a range of methods from group deliberations, to simulated risk controversies, to role playing and theatrical performances. This methodological commitment to context however is not equivalent to particularism or a retreat from theory. Bearing this out, his analytical approach focuses on key rhetorical arguments organised within themes, how these interplay with broader social discourses and narratives, and on how they relate to theoretical and policy concerns. In contrast, the decision sciences tradition, which Arvai et al. review, is not concerned with argumentation or discourse per se, but rather with the fundamental cognitive processes that govern (individual) judgments about risk, probability, and the construction of preferences. This emphasis on the underlying mechanics of reasoning - rather than on how they interplay with context and contingency to give rise to narratives and metaphors - leads naturally to research designs which are relatively abstract and idealised. The logic here is to strip away contextual influences, environmental variation, and irrelevant features of decision problems so as to better isolate the underlying cognitive processes. Credibility within this tradition depends on replicability - research designs are simplified and standardised so as to best ensure that the results unfold in the same fashion regardless of who conducts them, or where they are implemented.

Of course, replicability is not the same thing as generalisability, and a finding that replicates in standardised laboratory conditions may not necessarily transport to real-world settings. This is particularly true for the social rather than physical sciences, where the operation of underlying

mechanisms (*e.g.* cognitive and motivational processes) may be context, language and culture dependent, rather than uniform and invariant. Indeed a long-standing critique of the decision sciences has focussed on the perceived limited realism of their experimental settings. Commonly rehearsed arguments include that the experiments lack sufficient incentives for good performance; offer little to no opportunity for learning from peers or mentors; rely on toy problems that abstract away from everyday expertise and contextual cues ("urns and balls"); and sample from a population that may be somewhat psychologically unusual (people from Western, educated, industrialised, rich and democratic societies) (Levitt and List, 2007; Henrich et al., 2010; Jaeger et al., 2013; MacGillivray and Pidgeon, 2011; Green et al., 2016; MacGillivray, 2014a) . We have little to add to these critiques, save to say that *in principle* there is nothing intrinsically artificial about laboratory settings (Falk and Heckman, 2009). The question of sufficient realism turns on the details of the individual study design and on the cogency of the theoretical arguments used to justify any extrapolations drawn from it, not on the category of place it was conducted in (laboratory vs. field vs. model). Moreover, as research programs mature they typically progressively introduce features of context or realism into their designs, meaning that some of the above critiques carry less force today. Indeed somewhat ironically, many of the objections raised about the realism of experimental settings in the decision sciences - such as the importance of frames, social learning, and incentives - rely on evidence that has been generated from *within* those very experimental settings (Falk and Heckman, 2009; Camerer, 2011). However, whilst it is true that the behavioural economics and heuristics and biases traditions have been increasingly sensitive to those dimensions in their experimental designs, they still tend to favour the use of relatively idealised decision problems that abstract away from contextual cues (Hertwig and Ortmann, 2001; Green et al., 2016; Levitt and List, 2007). Interestingly, these fields are particularly influential in public policy and public discourse at the moment, a point to which we return later.

A separate line of critique that bears on the transportability of decision science research focuses not on the realism of the laboratory experiments, but rather on the validity of the model of cognitive processes that guides their design and interpretation. In brief, decision scientists typically a) assume that cognitive processes are domain-general, rather than domain-specific; b) adopt a dual-process model of judgment and reasoning, that distinguishes between unconscious, effortless, heuristic processes (intuitive), and rule-based, conscious, effortful and analytic processes (deliberative); and c) frame risk issues as tasks of estimation and choice (e.g. Kahneman, 2011; Slovic et al., 2004). These basic assumptions are in conflict with evolutionary psychologists, who generally reject dual process theories in favour of the concept of a modular mind, and conceive of cognitive processes as being a series of

domain-specific adaptations tailored to recurrent and persistent problems posed by social and ecological environments (Cosmides and Tooby, 1996; Gigerenzer and Gaissmaier, 2011). As Herbert Simon (1990) put it, "each kind of task to which the human mind addresses itself may be regarded as defining a different species of thought." In this paradigm, eliciting and evaluating processes of judgment and choice under uncertainty requires explicit attention towards domains of reasoning (*e.g.* making a medical diagnosis vs. playing roulette), contextual cues, and structures of information in the environment. Rationality from this perspective is about the adaptation of cognition to its environment, rather than to the norms of logic or probability theory (Gigerenzer and Gaissmaier, 2011). And so what decision scientists view as experimental designs that filter out noise and idealise away from context and problem content, evolutionary psychologists see as designs that exclude fundamental features of decision-making environments which shape the selection and operation of specific processes of inference and choice. For example, Gigerenzer and Hug (1992) showed that introducing task frames which encouraged people to view the famous "selection task" as a form of social-contract (i.e. a problem of co-operation or reciprocal altruism) initiated a cheater-detection algorithm which lead to vastly superior performance. More recently, Green et al. (2016) showed that the use of idealised decision problems - those that abstract away contextual cues - makes it difficult for experimental subjects to apply their everyday expertise, at least in conditions where expertise takes the form of domain or task-specific heuristics. How does this relate to transportability? Researchers within the evolutionary psychology tradition - most famously Gigerenzer and colleagues - have argued that the methodological commitments of the decision sciences have led to a skeptical view of lay cognitive capacities that bears little relation to how people make judgments about risk and probability outside of the laboratory (*i.e.* that the findings are epiphenomena restricted to artificial environments and toy problems designed - inadvertently or otherwise - to induce error; e.g. Gigerenzer and Gaissmaier, 2011; Gigerenzer, 1996; Mousavi et al., 2016). Relatedly, the decision sciences framing of risk problems as tasks of estimation and choice, together with their relatively shallow process analysis and commitment to dual-process theories, has led them to largely neglect informal logic, metaphorical reasoning, causal reasoning, moral evaluation, analogical reasoning, deliberative heuristics, and narrative reasoning about risk. When decision scientists have considered these forms of reasoning, they have typically done so within the framework of estimation and choice, *e.g.* in exploring how affect (an intuitively driven emotional valence) shapes perceived level of risk (e.g. Finucane et al., 2000), or conceiving of moral evaluations as post-hoc rationalisations for judgments arrived at by subconscious mechanisms (e.g. Haidt, 2001). They have not, in general, viewed them as autonomous processes that shape judgments,

values, beliefs, and preferences in relation to risk issues. In short, the idea that conscious thought may play a substantive role in shaping how people reason about risk appears to have dropped out of the thinking of the decision sciences (c.f. Fodor, 2006).

Of course, the rationality debates are almost as old as psychology itself, and there is probably little more to say of this particular version of it that has not already been committed to print. However, we would like to comment in passing on what appears to be a misconception common to many decision scientists and evolutionary psychologists. This is the belief that formal decision-theoretic methods - in other words, probability theory and utility maximisation - are applicable to a relatively limited subset of problem types. This is most explicit in the work of Gigerenzer and colleagues, who trace the notion back to Savage's (1972) distinction between small and large worlds. The argument is that decision theoretic approaches are applicable only to decision problems where states of the world, available choices, and their associated consequences and probabilities are known to the decision maker ("small worlds"). In "large worlds," characterised by uncertainty relating to these problem dimensions, Gigerenzer claims that Savage viewed the application of the full Bayesian apparatus as "utterly ridiculous."

"Savage carefully limited Bayesian decision theory to "small worlds" in which all alternatives, consequences, and probabilities are known. And he warned that it would be "utterly ridiculous" to apply Bayesian theory outside a well-defined world—for him, "to plan a picnic" was already outside because the planners cannot know all consequences in advance. (Gigerenzer and Marewski, 2015)

This, however, is based on a misreading of Savage's point. Savage in fact argued that in order to apply Bayesian methods to large worlds, we need to make various simplifying assumptions so that they can be analysed *as if* they were small worlds. This involves, for example, describing states of the world and consequences stemming from potential actions at some fixed and by necessity idealised level of detail (c.f. Shafer, 1986). Without doing so, the application of Bayesian methods would be "utterly ridiculous" as the problem structure would be ill-defined and the task intractable. The basic point is that whilst it is true that probability and decision theory can never solve problems of actual practice, they can in fact solve idealisations of those problems. And so the application of these approaches - whether intuitively or explicitly - is valuable to the extent that those idealisations are good ones (Jaynes, 2003; Savage, 1972). The question of what is a good or useful idealisation depends on the purpose of the exercise, and is inevitably judgment-laden, rather than answerable within the framework of decision theory itself. Of course there are other pragmatic constraints to the application of decision theoretic

approaches, e.g. where there is insufficient theoretical knowledge to support idealisation, or there is a lack of reliable data, or because decisions are simply urgent. In such situations, inexact, heuristic methods of problem-solving must be relied upon. But this is quite orthogonal to the distinction between small and large worlds.

Intriguingly, whilst the authors of all three chapters adopt quite different methodological and theoretical commitments, their normative arguments show striking commonalities. They all advocate increasing the engagement of citizens in decision making on risk and innovation, whether in terms of upstream engagement (Macnaghten), or enhancing communicative competence and finding better ways of mediating between conflicting stakeholder interests (Renn), or improving decision support and problem-structuring methods (Arvai et al.). Yet this sits alongside the troubling recalcitrance of the "deficit model" within regulatory agencies and elite scientific institutions and advisory panels (Wynne, 2006; Rayner, 2004; MacGillivray and Pidgeon, 2011). This model presupposes systematic disagreements between experts and laypeople on evaluations of risk issues, and attributes such gaps to deficits in factual knowledge or, more recently, deficits in reasoning capacities on the part of the public. This leads naturally to a concern that such "erroneous" risk perceptions may be replicated in law, policy, and regulation, as democratic governments respond to the (mis)fears of the citizenry (MacGillivray, 2014b). These concerns have catalyzed an influential school of thought, which prescribes a relatively technocratic approach to regulating risk, characterized by a high degree of deference to formal risk and cost-benefit analysis in the policy-making process (e.g. Sunstein, 2008; Breyer, 1993). This is intended to provide institutional safeguards that screen out the malign influence of heuristic-based, error-prone lay judgments, and so help ensure rational risk regulation. This school of thought—and its close cousin, the Nudge agenda (Thaler and Sunstein, 2008)—has intimately shaped policy debates and practices throughout the West. Nevertheless, the basic argument has been challenged on a variety of fronts. It has been critiqued as paternalistic or even undemocratic, in that it fails to respect citizen preferences, accused of downplaying the value-laden and approximate nature of formal risk and decision analysis, and, most relevant to the above discussion, portrayed as being rooted in an oversimplified and uncritical reading of the risk perception literature (Kahan et al., 2006; MacGillivray 2014b and references therein). It is no small irony that a subset of the findings from the decision sciences - mostly within behavioural economics, but also a somewhat skewed interpretation of the heuristics and biases tradition - has travelled so easily into institutional settings, despite longstanding questions surrounding their realism and generalisability.

Conclusions

We conclude by restating our arguments. Whilst the early environmental movements were closely tied to threats to particular places, the modern sustainability crisis is characterised by diffuse, global, and potentially catastrophic risks. This sits alongside a widespread public sense of apathy and fatalism, in relation to challenges ranging from climate change to deforestation to global food security, and a skepticism of the capacity of the regulatory state to foresee and manage the consequences of scientific and technological innovation. Whilst many risk management institutions have responded with official rhetoric emphasising the need to improve public participation and rebuild trust, their actual practices have often been rather reductive and exclusionary, focussed more on dampening controversy and educating an unruly public, rather than on meaningful, upstream engagement. In part this stems from a logic of risk governance that presupposes relatively restrictive norms of risk analysis (e.g. reinforcing a strict fact-value dichotomy), and in at least equal measure from the surprising recalcitrance of the "deficit model." One consequence of this long-standing instinct to discipline public reason is that recent methodological advances in problem structuring tools and in the design of forums for upstream engagement have yet to be implemented at the scale one might like. Meanwhile, the rationality debate rumbles on, with decision scientists and evolutionary psychologists still warring over what norms should be used to evaluate decision-making under uncertainty, how the mind is structured, as well as disagreeing on more esoteric aspects of experimental design and analysis. They do seem to agree that decision-theoretic approaches are inapplicable to "large worlds;" we have argued that this is incorrect and is based on a misinterpretation of Savage. They also seem to share a relative neglect of higher order processes, that is, of the study of how people *reason* about risk, focussing instead on tasks of estimation and choice. Skinner would have been amused. In the midst of this, a highly selective and partial reading of the decision sciences has travelled rather easily into risk management institutions, allowing for the reconstruction of the seemingly invincible deficit model. And so the predominant logic of risk governance remains focussed on supplanting fallible lay judgments with rational calculations of risk and benefit, an ideal that is as old as Plato (Hacking, 2014) and that defined Enlightenment thought (Porter, 2011). Plus ça change.

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