

Adding RRI to the 3Rs: What could Responsible Research and Innovation offer animal research governance?

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Introduction

Complexity, uncertainty, and often controversy, are manifest at the interface between technoscience and society (Callon et al. 2003; Nowotny et al. 2001). The latter part of the 20th century saw a global wane in optimism about scientific progress and 'science is no longer indisputably a force for good' (Sykes and Macnaghten 2013, 86), nor seen as an autonomous, objective, authority (Polanyi, 1962). In the UK, previous controversies over the BSE outbreak, the use of nuclear power, and GM crops have tested public faith in 'responsible' science, as well as unsettling 'public trust in scientific expertise and its relation to public policy-making' (Whatmore 2009, 589). Animal laboratory experimentation is another controversial topic with a long history of polarised dispute about what counts as responsible and legitimate science (Rupke 1987; Tester 1991). Animal research is also a high stakes arena where life and death decisions are made; where the safety and efficacy of new pharmaceuticals are tested; and where significant progress is made in understanding human and animal biological processes. To paraphrase an old adage: with these high stakes, comes great responsibility. Sociological and philosophical scholarship connects responsibility with authoritativeness, legitimacy and trust, and within literature on governance 'the concept of responsibility is invoked with considerable frequency' (Pellizzoni 2004, 542), albeit framed in a variety of ways within different contexts (Stilgoe et al. 2013).

Over the past four decades, public scepticism and mistrust about justifications for animal experimentation to advance scientific goals have increased (Michael and Birke 1994; Ormandy and Schuppli 2014; von Roten 2012). The 3Rs principles (Replacement, Reduction and Refinement) have grown to be a central lynchpin for demonstrating 'responsible' science and welfare in animal use. They have become conventionalised within animal research policy and practice in the UK and EU (GOV UK 2015), the US (Horner and Minifie 2011), and are increasingly incorporated into other governance frameworks internationally (CCAC 2015). Public opinion polls on animal research have also demonstrated over time that support for animal laboratory experiments is dependent on the application of the 3Rs (Robinson 2014). However, as this paper will elaborate, the mobilising of the 3Rs in the governance of animal research can operate as both an 'opening up' and 'closing down' mechanism (Stirling 2008) particularly in relation to questions about who is able to take responsibility for decision-making on the governance of animal research.

Responsible Research and Innovation (shortened to RRI) is a recent variation on the theme of 'technology assessment' frameworks, which have developed since the 1970s in order to forecast, monitor, and shape science and technology developments (Kranakis 1988; Grunwald and Achternbosch 2013). RRI emphasises the importance of a reflexive and inclusive relationship between science and society throughout the lifecycle of a research and innovation process (Owen et al. 2013a; von Schomberg 2013), with the ambitious goal of ensuring 'policy choices can be coproduced with publics in ways that authentically embody diverse social knowledge, values and meanings' (Owen et al. 2012, 757). Thus far, the concept of RRI has not been linked with the governance of animal research, although as will be discussed below, the notion of 'responsibility' is widely articulated in connection with the 3Rs. Conversely, almost no attention has been paid to animal research within RRI literatures, beyond a brief mention in the 'Preface' to *Responsible Innovation* (2013) where the goals of the book describe how science and innovation might be conducted taking into account: 'a greater moral dimension, to those living now, those yet to be born, and *those beyond our own species* (Owen et al. 2013b, xix, emphasis added).

At this juncture, it is difficult to ascertain why animal research has largely been overlooked within the RRI literature, but perhaps this relates to the broad range of complex activities that fall under the umbrella of animal research. Some aspects of laboratory animal experiments more clearly fit under a descriptor of 'science and innovation'; for instance, the development of new pharmaceutical products. However, other aspects are more tangential, such as basic or fundamental research, which is less easily linked to an 'innovation pathway'. There may also be some reluctance to interfere with well-established areas of technoscience, which have substantial investment tied up in R&D (de Saille 2015, 9). However, the troubled history of animal research also needs to be taken into consideration. In the UK, for example, so called 'animal extremism', coupled with exposés of unethical behaviours within some institutions, has created what the Head of Animals in Science Regulation Unit terms, a 'vicious circle of mistrust' between scientists and wider society (MacArthur Clark 2015). Finally, there is a question about whether RRI is primarily a 'human-centric' framework, concerned only with the social, environmental and ethical ramifications of technoscience on the human species. Greater clarity is needed about whom and what RRI is ultimately responsible for, and where non-human animals fit within this schema. As a currently 'undone' (Frickett et al. 2010) area of research inquiry, this position piece seeks to fill this gap and help stimulate further research at this interface.

This paper draws on work from a recently completed 30-month project on xxx,ⁱ funded by the xxx.ⁱⁱ During the course of carrying out this research, it became clear the 3Rs have become a powerful touchstone within the governance of animal use, and the animal research industry, and that these principles were a key route through which ‘responsibility’ could be demonstrated, and experimental use of animals, legitimated. At the broader level of techno-science governance, the concept of RRI has received increasing attention from funders and academics (Pearce et al. 2013). Therefore, to further understand the discourse relating to the 3Rs and constructions of ‘responsibility’, which had tangentially emerged from the core project work, a scoping study (Arksey and O’Malley 2005) was undertaken. Through scoping, the aim is to synthesise and analyse ‘a wide range of research and non-research material to provide greater conceptual clarity about a specific topic or field of evidence’ (Davis et al. 2009). In late 2014, four interviews specifically relating to the topic of the 3Rs and RRI were conducted with policy makers, including an academic with expertise in RRI, and three representatives from UK funding organisations. These interviews were exploratory, with the aim of identifying issues or themes which could make up recommendations for relevant areas for future research. A documentary analysis was also undertaken, which included policy documents and other grey literature, media reports, and webpages relating to responsibility, animal research and the 3Rs. This scoping material and insights from the aforementioned programme of research, inform the conceptual and policy reflections presented here, and indicate future directions to elaborate this work.

I will begin by sketching out the place of the 3Rs in the governance of animal research, and explore the centrality of the notion of responsibility within the policy framework associated with these principles. The next section will introduce the conceptual framework of RRI, highlighting areas which could be usefully translated into the governance of the 3Rs. Following this, the 3Rs will be considered in relation to four key dimensions of RRI: anticipation, reflection, deliberation and responsiveness, developed by Owen et al. (2012). The final section outlines propositions for the future direction of the research agenda proposed here. In exploring the dynamics between the 3Rs and RRI frameworks, this paper provides a useful case for STS scholars interested in how science and wider social and ethical concerns connect to both collective and individual actions.

The 3Rs and ‘responsible’ research

Russell and Burch’s *The Principles of Humane Experimental Technique* was published in 1959, and the influence of their philosophy has gradually increased over the past five decades (see Kirk,

under review). In this book three ethical principles governing animal research are proposed: Replacement, Reduction and Refinement:

‘Replacement means the substitution for conscious living higher animals of insentient material. Reduction means reduction in the number of animals used to obtain information of given amount and precision. Refinement means any decrease in the incidence or severity of inhumane procedures applied to those animals which still have to be used (Russell and Burch 1959, 64).

However, it was not until 1986 that the 3Rs were incorporated into EU legislation via Directive 86/609/EEC *on the protection of animals used for scientific purposes*. Due to treaty obligations, this legislation had a widespread influence across all Member States. Whilst the ‘3Rs’ are not referred to as such, the doctrines of reduction, refinement, and replacement are embedded within the articles of the Directive. For example, Article 7(2) states: ‘an experiment shall not be performed if another scientifically satisfactory method of obtaining the result sought, not entailing the use of another animal, is reasonably and practicably available.’ Article 7(3) requires that any chosen procedure must use ‘the minimum number of animals’ and it must cause ‘the least pain, suffering, distress or lasting harm’ (Rusche 2003, 67-68).

When the 1986 Directive was replaced in 2010 by 2010/63/EU, one of the key aims was ‘to firmly anchor the principle of the Three Rs...in EU legislation’ (EC 2015). Correspondingly, the UK Animals (Scientific Procedures) Act 1986 (ASPA), amended in 2012 also now explicitly refers to the 3Rs framework. The increasing significance of the 3Rs within the governance of laboratory animal research, is reflected within literatures from scientists, universities, funders and industry. Promissory discourses from the scientific community connected to the 3Rs, express the hope that by endorsing and following these principles, wider society can be reassured good scientific and welfare practices are being followed within the animal laboratory. This is exemplified in a BBC News (2014) report on the UK Government’s delivery plan for the 3Rs in which David Willetts, the former Minister of Universities and Science, states: ‘Britain is a world leader in science but also in concern for the welfare of animals. What we are doing is bringing these two great traditions together. We are absolutely committed to the 3Rs’.

The 3Rs, therefore, are imbued with both scientific and moral authority, and the notion of researcher ‘responsibility’ and ‘responsible research’ are often used to highlight both scientific robustness and humane ethical practice. The concept of responsibility is being mobilised at both

the individual level and with relation to good scientific practice more broadly at the organisational level. Institutions and industry that use animals in their research often make reference to the 3Rs, and it appears this is 'used as evidence of the research community's commitment to meet high ethical standards in the care and use of laboratory animals' (Olsson et al. 2012, 333). For example, the University of Oxford state on their website that they are 'committed to pursue a policy of reduction, replacement, and refinement (3Rs) in all animal based research and to promote knowledge of the moral and legal responsibilities and a culture of care in all aspects of research' (University of Oxford 2015).

Emphasis on responsibility resting with the individual researcher can be traced back to the Cruelty to Animals Act 1876, where the legislation placed the onus on individual researchers to act ethically (O'Donoghue 1980). Some commentators have argued this is beneficial because 'the licensee himself [sic] is *responsible* for the animals he uses and must satisfy himself that the animals are properly cared for in every way' (Uvarov 1984, 55, emphasis added). More recently, it has been argued, 'even when animal use is tightly regulated and supervised, the individual researcher's responsibility is still decisive in the implementation of the 3Rs' (Franco and Olsson, 2014). This emphasis on individual responsibility is often also found in animal research advocacy organisations. The European Animal Research Association (EARA) for example, states: The 3Rs principles...establish the accepted standards for humane experimentation on animals. These principles are endorsed and incorporated by all *responsible scientists* (EARA 2015, emphasis added).

At the broader governance and legislative level, the original embedding of the 3Rs principles within the 1986 EU legislation was clearly tied to expectations of 'responsible animal research', and more attention to ethical dimensions within animal research (Matthiessen et al. 2003). More recently, the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs), in collaboration with six other major UK funding bodies, has produced a set of guidelines entitled *Responsibility in the Use of Animals in Bioscience Research* (2014). Within the guidelines, various responsibilities are set out for researchers, ethics committees, and peer reviewers to ensure implementation of the 3Rs. These responsibilities are mainly tied to legislative obligations, and it is notable that there is no mention of responsibility to the general public or wider society.

The pharmaceutical industry also clearly intertwines the notions of ‘responsibility’, scientific rigour, and ethics, with the application of the 3Rs. Extracts taken from company webpages which refer to animal experimentation provide an illustration of this. For example, AstraZeneca (2015) state: ‘The 3Rs are at the centre of our commitment to *good science* and the *responsible* use of animals’ (AstraZeneca 2015, emphasis added). Two further examples from large industry players also link responsibility and the 3Rs: ‘At Lilly, we know we have both an *ethical and a scientific responsibility* toward animals used in research. That’s why we have adopted “3Rs” when it comes to our principles of animal care and use’ (Lilly 2015, emphasis added). ‘It is our *responsibility* to use the most appropriate methodology and to aggressively seek scientifically valid 3R approaches to animal research’ (Merck 2015, emphasis added). These examples illustrate how central the 3Rs have become to the pharmaceutical industry for allaying potential concerns about using animals in the development and testing of medicinal products, while at the same time allowing scientific research to continue. High-profile British scientist Lord Robert Winston argues that a further responsibility is ensuring the public are aware animal testing is a fundamental aspect of drug development, and he has campaigned for mandatory labelling of medicinal products to that effect (see McLeod 2014).

Limitations to the 3Rs framework

Although many commentators are positive about the scientific and ethical benefits of implementing the 3Rs, others are more critical. Some critics see the 3Rs have little merit whatsoever (e.g. Derbyshire 2006; Safer Medicines 2012), with others seeing some virtues, whilst raising concerns about limitations of this framework (e.g. Fenwick et al. 2009). Olsson et al. (2012) argue there is an ethical ‘gap’ in the 3Rs, because of both direct and indirect conflicts that arise when promoting Replacement, Reduction and Refinement. These conflicts highlight a lack of agreement about the values underpinning these principles. In particular, there is debate about the importance placed on the goal of Replacement. Anti-vivisection and animal protection groups often argue that full ‘Replacement’ is feasible and imminent, whilst many from the laboratory animal science community assert some animal use will always be necessary, and therefore Refinement and Reduction are also vitally important. The authors conclude consensus on the values underlying the 3Rs is likely to be impossible, which reinforces the ‘need for *deliberation* involving researchers and the public in developing sensible policies that address these issues’ (Olsson et al. 2012: 335, emphasis added). This debate around ‘Replacement’ highlights the ambiguity surrounding what responsibility means, both in the sense of ‘responsible science’, and when applied to the operationalisation of the 3Rs. For example,

various critics of animal research are concerned that the 3Rs are not being fully implemented, while some anti-vivisection organisations dispute there is any usefulness in applying the 3Rs because the principles of Reduction and Refinement implicitly support the continued use of animals in laboratory research (House of Lords 2002: 12).

An oft-cited suggestion, first proposed by Banks (1995), is that a fourth 'R' - 'Responsibility' - should be added to the 3Rs framework. This is reflected on the website of a specialist laboratory testing facility: 'At Wickham Laboratories, we also believe in a 4th R – that of *responsibility* to our animals, society and the environment' (Wickham Laboratories 2015). Rowan and Goldberg (1995) also outline various schemas that augment the 3Rs with a list of eleven words starting with 'R'. Obviously a framework of '11Rs' would be unworkable, so they settle on suggesting a framework of six 'tree sets' (the original 3Rs and three more). One of the most important additional 'Rs' is 'Responsibility', which they argue is important because 'in order to pursue wisdom, one must have a sense of responsibility to one's fellow humans, to non-human animals, and to the whole environment' (Rowan and Goldberg 1995: 307). Some social science and humanities scholars have also interrogated the relationship between ethics and notions of responsibility in relation to animal research (see Greenhough and Roe 2010, for useful discussion). For example, Haraway argues for a more embodied 'shared suffering' with animal subjects, in order to accomplish what she terms 'response-ability' (Haraway 1997: 71-83). Importantly in the context of RRI, Haraway's thesis emphasises ethical decisions relating to animal use need to be transparent (in the sense that animal suffering should be openly acknowledged), and that there is collective responsibility for the harms and benefits which result from animal research.

What is clear from the limitations outlined above is not everyone agrees with the notion that applying the 3Rs to research will necessarily also result in scientists acting 'responsibly', or that this framework addresses all the complex science and welfare issues associated with animal research. However, the main concern with the application of the 3Rs, particularly within the existing regulatory framework in the UK, is that these varying views are not given space for discussion. Currently decision-making around the application of the 3Rs, and harm-benefit assessments are carried out within the UK project licencing process (explored further below), with little or no opportunity for input from wider society. The following section will explore whether an RRI approach could promote greater opportunities for a broader range of societal actors to be involved in the shaping of the direction of animal research.

Enhancing the 3Rs through dimensions of RRI

RRI is an influential and dynamic policy tool which seeks to enable publics, scientists, policymakers, and other societal actors to work together to proactively deal with the conditions of uncertainty intrinsic to emergent science and technology enterprises, in order to ensure these are evolving to meet societal needs. Or put another way, RRI seeks to take 'care of the future through collective stewardship of science and innovation in the present' (Stilgoe et al. 2013, 1570). RRI is an umbrella framework, which pulls together strands from Technology Assessment (TA) (and its variationsⁱⁱⁱ), Science and Technology Studies (STS), Corporate Social Responsibility (CSR), Ethical, Legal, Social, Aspects (ELSA) and other governance frameworks (Grunwald 2011; Rodemeyer et al. 2005; Zwart et al. 2014). RRI (and its antecedents to varying degrees) seeks to blur the notion of a science-society binary, in order to ensure ethical and social constituents are considered alongside scientific evidence in decision-making about the direction of science and innovation (Guston 2013; Jasanoff & Wynn 1998; Rayner 2003; Stirling 2008). There is also an emphasis on the importance of initiatives to provide structural support for individual scientists and engineers to assume moral responsibility for their work and education about related value-based issues (Doorn 2012; Pellizzoni 2004; Swierstra and Jelsma 2006).

RRI also links the concept of responsibility to technoscience innovation. In this context, innovation is a dynamic process that needs to be managed through unpredictable and uncertain circumstances, which may, or may not, result in a positive outcome (Bessant 2013). Therefore, it is important that responsibility is shared '*throughout* the innovation enterprise' (Fisher and Rip 2013, 165). Currently, there are multiple visions about how RRI should be defined and mobilised moving forward (de Saille 2015), and associated debates are 'neither easy nor comfortable' (de Bakker et al. 2014, 295). Despite UK and EU funding institutions progressively introducing mandatory requirements for RRI to be included in science programmes, as yet there is no international standardisation of mechanisms for implementation (Wickson and Forsberg 2014). As the notion of RRI has developed in the EU context in particular, there is concern the focus has moved 'towards the imperative of speeding up innovation to produce immediate economic growth' (de Saille 2015: 159). Additionally, there is some apprehension as to whether a standardised RRI framework will strike the right balance between potentially being too 'nebulous' or too inflexible (Hartley et al. 2015, 14).

Although there is currently some heterogeneity in the understandings of how RRI should be mobilised, it is useful for the purposes of this current analysis, to focus on the 'Framework for Responsible Innovation' (Owen et al. 2013a; Stilgoe et al. 2013), which has developed primarily within a UK academic context. This framework emphasises the importance of reflexivity and inclusion throughout the lifecycle of an innovation process by continuous commitment to four (interrelated) dimensions: anticipation, reflection, deliberation and responsiveness. As I will elaborate in the remainder of this section, these four dimensions are also relevant and provide a valuable lens through which to examine the governance of animal research.

The concept of *anticipation* aims to improve foresight of risk issues associated with technoscience innovation by encouraging researchers to think deeply and systematically about potential impacts of their research, taking into account not only innovation opportunities, but also being alert to social and ethical implications (Owen et al. 2013a). In the context of animal research, the harm-benefit analysis weighs up anticipated benefits of the research against potential harms to the animals. As an anticipatory exercise, the harm-benefit analysis has been criticised for too much focus on the promissory benefits to health and biomedicine, and not enough consideration of potential harms, as well as a lack of transparency around the ethical review process (Varga 2013). However, there is some space within the governance of animal research in the UK for researchers to consider potential impacts of their research, specifically in relation to the 3Rs. Animal research is regulated under the Animals (Scientific Procedures) Act (ASPA) and each study must be covered by a Project Licence (PL). This is applied for through the UK Government Home Office (HO), but must also be reviewed through a local Research Ethics Committee (REC). The PL Application form includes a section on the 3Rs, requiring the PL applicant to describe how they are in compliance with the principles of replacement, reduction and refinement. This includes justification for using any protocols categorised as 'severe'^{iv} and there is also now a requirement for a retrospective assessment of the actual severity of procedures experienced by animals during the course of the research. Whilst this example does suggest there is at least some implementation of the aims of an anticipatory dimension, it does not allow for consideration of wider ethical or social aspects of the research to be reflected on, as will be outlined next.

Closely connected to anticipation, the *reflection* dimension in an RRI framework directly links responsibility within technoscience innovation practice, to the obligation for researchers to reflect on the values that underlie their own work and broader governance systems. This

includes critically examining the ethical, political, social and economic assumptions that often motivate innovation processes. A consequence of reflexivity is greater openness within science and innovation, about the uncertainties that are part of these processes (Owen et al. 2013a). In terms of the ASPA PL process, it is worth considering how more reflexive opportunities for animal researchers could be integrated. As already mentioned, PL applicants must anticipate scientific and welfare aspects of implementing the 3Rs. However, researchers are unlikely to be mindful of ‘assumptions of scientific amorality and agnosticism’ (Stilgoe 2013, 1571) during the development of a research protocol, or the PL application process. There has been some recognition of the importance for animal researchers to be able to reflect on the moral and ethical values that are inherent to animal experimentation. For example, the US psychologist John Gluck states: ‘The use of animals in research should evolve out of a strong sense of ethical self-examination... [that] involves a careful self-analysis of one's own personal and scientific motives. Moreover, it requires recognition of animal suffering and a satisfactory working through of that suffering in terms of one's ethical values’ (Gluck and Kubacki 1991). I do not mean to suggest animal research scientists are necessarily non-cognisant of personal motivations in their work, nor the contentious nature of animal research. However, while ‘most researchers are highly ethical individuals’ (Curzer et al. 2015, 2), little space is allowed for reflection on personal values, or how animal research fits within the wider socio-political and economic landscape, particularly during the development of research protocols or within the ASPA licencing process.

Moving on to the third dimension, the notion of *deliberation* within an RRI framework allows for inclusive deliberative opportunities between citizens, stakeholders, scientists technologists, policy-makers (and so on), bringing about truly ‘collective’ decision-making on the governance of science and innovation. Internationally, there is concern that there are currently insufficient mechanisms for including public views and concerns within the governance of animal research (Ormandy and Schuppli 2014, 401). In the UK, Animal Welfare and Ethical Review Bodies (AWERBs) consider PL applications, including ethical issues associated with the use of animals. These committees are made up of scientists, animal care staff, a veterinary surgeon, and normally one independent external lay member, although the inclusion of a lay member is not mandated by the ASPA regulatory framework. The Science Media Centre (2013) states: ‘This [ethical review] process includes the views of non-scientists and lay people, *spreading the responsibility outside the academic and scientific community*’ (Science Media Centre 2013, emphasis added). This idea of ‘spreading responsibility’ is a central aim of RRI, but it is questionable how much the current PL system actually enables this to happen. Some animal

welfare organisations have called for ‘wider scientific and public scrutiny of PL Applications, *before* the licence is awarded’ in order to ‘ensure adherence to the Government’s 3Rs policy’ (NAVS 2015). The general response from institutions is this would be unworkable. However, in response to the recent Concordat on Openness on Animal Research, some UK universities do appear to be creating new transparency initiatives for the public (Petty-Saphon 2015). Whether these initiatives will include deliberative opportunities for interested citizens, or enable feedback from the public to be incorporated into the direction of animal research, remains to be seen.

The fourth RRI dimension, *responsiveness*, emphasises the necessity for flexibility within research and innovation processes, and the capacity to alter the direction of research in response to changes in societal ‘perspectives, views and norms’ (Stilgoe 2013, 1572). Responsiveness often incorporates the three previous dimensions, in order to ‘set the direction and influence the subsequent trajectory and pace of innovation, through effective mechanisms of participatory and anticipatory governance’ (Owen et al. 2013a). A number of key animal research commentators have also utilised the idea of ‘responsiveness’, particularly in relation to its importance for public confidence in ethical decision-making (Smith and Boyd 1991; Smith et al. 2007). Animal laboratory research is bound up with multiple, competing societal viewpoints about animals and their moral status, and disputes about which types of human exploitation of animals are acceptable. This means animal researchers must legitimise their work by engaging in some forms of ‘moral argument’ which reflects these societal views (Michael and Birke 1994, 190). There are some examples where changes in the ‘moral landscape’, have led to changes in the instrumental use of animals, such as the case of monkey experiments in Denmark (see Koch and Svendsen, 2014). However, such changes will not be easy or fast, as animal research continues to be a contradictory, complex and divisive topic (Ascione and Shapiro 2009). Nevertheless, by incorporating responsiveness within the governance of animal research there could be more capacity for responding to emerging knowledge, viewpoints, and norms. Importantly, this would also facilitate shared responsibility for using animals for experimental purposes across a broad range of societal actors, something which is currently lacking in the existing governance of animal research.

Propositions for a future integrative research agenda

The previous sections have illustrated that the notion of ‘responsibility’ is frequently mobilised in connection with the 3Rs, at both the individual and organisational level, in order to demonstrate

high welfare and scientific standards. Previous work has emphasised, an ethical ‘gap’ in the 3Rs framework (Olsson et al. 2012). An RRI framework is helpful, because it ‘implies a need to expand the basic normative concept of responsibility beyond the dominant legal and consequentialist paradigms’ (Patel et al. 2014: 9). The 3Rs framework has become a vital symbol of ‘good’ science and welfare practices, yet the applications of these principles within experimental research design are not generally open to any deliberative or public engagement processes, and the governance structure lacks flexibility. In other words, the application of the 3Rs opens up a process for ensuring appropriate scientific and welfare decisions are being made *within* the laboratory, but opportunities for deliberation about the *wider* socio-political framing and decision-making about animal use in response to human health and medical issues are closed down (Stirling 2008). Developing a governance framework which allows animal laboratory research to be considered in the context of wider ethical, social and political issues may be a complex and difficult proposition. Nevertheless, in the following section, I will summarise four main propositions for a future research agenda that takes a more integrative approach to the 3Rs and RRI, which could help move towards a goal of more collective and contextualised decision-making about animal research.

‘Reframe responsibility’ in the context of the 3Rs

Owen et al. (2012) suggest one of the main intellectual contributions of research relating to RRI could be ‘reframing responsibility’ within innovation as a collective, uncertain activity where attention is focussed on aspects such as, ‘care and responsiveness that are values and not rules-based’ (Owen et al. 2012, 756). In the context of the 3Rs and animal research, this could mean more consideration of the ‘messiness’ and uncertainty within an animal laboratory setting, and the ways in which values, emotions, and ethics of care are intertwined with scientific and welfare responsibilities (for an ethnographic investigation relating to this, see Greenhough and Roe, under review). Future research is needed to unpack the oft-cited, but rarely analysed, notion of responsibility in the context of animal research. This is particularly important in relation to the 3Rs principles, as they are increasingly becoming the ‘gold standard’ for scientific and welfare excellence.

Embed ‘deliberative responsiveness’ into animal research governance

Over the past decade, new frameworks and tools for fostering a more deliberative relationship between science and society have proliferated (e.g. Delgado et al. 2010; Jasanoff 2003; O’Doherty and Einsiedel 2013; Stilgoe et al. 2014; Stirling 2008). This scholarship can help inform

the current lack of opportunities for animal research to be responsive and flexible to changes in societal outlooks and viewpoints. This has already been highlighted by some scholars (see Burgess et al. 2007; Davies 2006; Davies & Burgess 2004), and could be reinforced through an RRI lens. The RRI responsiveness dimension emphasises the importance of incorporating public engagement within a flexible governance structure that allows for animal research to be modified and changed, where appropriate, to reflect wider societal concerns. One potential route for this could be to provide more opportunities for citizens to be part of the assessment process of the PL licence process. While this may not be feasible for every individual licence application, it could be possible to identify key areas where lay people could have more input. The following extract from a Federation of Animal Laboratory Science Associations (FELASA) working group summarises how responsiveness could potentially operate within a PL ethical review process:

‘Ethical review processes should involve a diversity of participants who hold a variety of perspectives...and encompass a range of relevant expertise. Opportunities should be provided for the different participants to *engage in discussion*, and so ensure that the ethical review is informed by and responsive to a range of different perspectives, and that ethical thinking can evolve with experience rather than merely rest with the *status quo*’ (Smith et al. 2007, 148).

Facilitate greater reflexivity within 3Rs decision-making

The 3Rs have become the standardised ‘metric of progress toward the improved well-being of laboratory animals’ (Carbone 2011: 2). However, the scientific merits of the 3Rs are increasingly being highlighted (e.g. NC3Rs 2015), with less emphasis on ‘humaneness’, which was so important to Russell and Burch (see Kirk, under review). This fits with the claim scientists often have a strategy of ‘deflecting ultimate responsibility to an abstract and amorphous society’ (Kerr et al., 1997). In other words, ‘society’ is held responsible for some of the more ‘ethical’ or values decisions made in the laboratory. Hobson-West (2012) argues animal research scientists draw a discursive boundary in their work, reflecting the distinction that ‘society’ makes as whole, in relation to the rights of humans and non-human animals. She contends boundaries are created and maintained not between science and non-science, but between *ethically* acceptable scientific research, and that which is not. The application of the RRI dimension of reflexivity to animal research could open up a space for animal researchers to more critically evaluate the values and subjective assumptions which contribute to their decision-making, and the governance of animal use more broadly. It would be productive for future research to explore

how greater reflexivity could be supported, and to investigate how the scientific, emotional and ethical 'processes of co-production' (Pickersgill 2012) within animal laboratory research are shaping knowledge outcomes. In particular, there needs to be more reflexivity and clarity about decision-making by different actors during the PL process.

Institute collaborative interdisciplinary opportunities between sciences, social sciences and humanities

Interdisciplinarity lies at the heart of RRI. This is both a strength and a challenge. An interdisciplinary approach is necessary in order to ensure research and innovation is tuned to the needs of society (Schuurbiers et al. 2014, 4). Working together, social researchers, scientists and other stakeholders can capture an understanding of 'public values' during the innovation process, whilst feeding back information about the research and innovation processes to broader societal actors. Interdisciplinary collaborations between natural and social scientists can also be an opportunity to clarify and develop key questions concerning laboratory animal science and welfare. This is clearly a feature of EPSRC-funded Synthetic Biology centres in the UK, where some social science involvement has become integrated within funding requirements (see Owen and Goldberg 2010). Kerr (2012) argues this presents an important opportunity for 'matters of care' to be actioned within RRI, and for STS scholars to work collaboratively with scientists to help prioritise aspects of care within research and innovation. This feature of RRI links back to the original fears raised by Russell and Burch (1959) relating to the tyranny of specialisation, and their urging for social sciences and humanities to play a role in humane experimental design in the animal laboratory (see Kirk, under review). However, some challenges need to be considered with interdisciplinary work, such as how to overcome issues such as 'limits to participation', 'barriers to communication' and the importance of supporting logistics and mediation for the different disciplines (Gunnarsdottir 2012, 3-4). A more radical suggestion is for social science and humanities scholars to be *embedded* within animal use facilities. There are some examples in other areas of technoscience where this has been extremely productive in facilitating collaborative 'situated critical reflection' which combines 'different ways of thinking and knowing' between scientists and social researchers (Schuurbiers 2011, 785). This 'midstream modulation' approach (Fisher et al., 2006) seeks to build capacity in science and innovation for versatile reflection and responsiveness to 'societal visions' throughout the R&D process (Wynne 2011).

Conclusion

This paper has explored the merits of integrating dimensions of an RRI framework into the governance of animal research and the application of the 3Rs. An advantage of taking an RRI approach is that it allows for important elements of existing techno-science governance mechanisms to be integrated and ‘embedded into the trajectory of research and innovation’ throughout the entire process (Patel et al., 2014: 57). The use of laboratory animals in research continues to be a difficult and contested area of technoscience, it could be argued, precisely because social values and scientific methods are so intrinsically entangled, and ultimately the outcomes of harms and benefits are so capricious. Applying an RRI approach to animal research could allow for policy choices [to] be coproduced with publics in ways that authentically embody diverse social knowledge, values and meanings’ (Owen et al., 2012, 757).

There are certainly challenges in moving from the theoretical and aspirational discourse of RRI, towards mobilising this framework in real world circumstances. There is also a need for further work to elucidate where non-human animals fit within an RRI schema. Despite these caveats, this paper has indicated pursuing an RRI approach in the context of animal research is a worthwhile endeavour, which could allow for deeper consideration, and even reframing, of the notion of ‘responsibility’. Importantly for the current governance of animal research, this also allows for the uncertainty of innovation to be made front and centre, dealt with in a truly collective and deliberative way, and in a manner which prioritises care and responsiveness (Owen et al. 2012). Ultimately, the knowledge produced from animal research is the outcome of complex scientific, social, political and ethical processes, which travel along a trajectory that is riddled with ambiguity about the ultimate outcomes of the research. Adding elements of RRI to this journey could help ensure a more collective decision about the direction of travel, and how and when it is appropriate to exploit animals’ lives along the way.

Notes:

ⁱ The work was based at the University of Nottingham, under PI, Pru Hobson-West.

ⁱⁱ This included collation of documents relating to transparency and animal research in the UK (see McLeod and Hobson-West, 2015); interviews with ten animal research stakeholder organisations on the topic of a Home Office consultation; and a further interview and focus group comparing UK and Swiss case studies animal research transparency initiatives. Ethical review for this research was provided by School of Veterinary Medicine and Science Ethical Review Committee.

ⁱⁱⁱ These include variations such as: Participatory TA, Constructive TA, European Parliamentary TA, Real Time TA (see Armin 2011; Guston & Sarewitz 2002; and Rodemeyer et al. 2005).

^{iv} The HO provides four severity categories for animal research: 'mild' (involving short-term mild pain), 'moderate' (involving short-term moderate pain) and 'severe' (involving severe pain, suffering or distress). The fourth category, 'non-recovery', covers procedures which are carried out entirely under general anaesthesia, and where the animal does not recover consciousness. For full details of the severity classification procedures, see Home Office 2014, 118-121.

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