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Two tribes or more? The historical emergence of discourse coalitions of responsible research and innovation (rri) and Responsible Research and Innovation (RRI)

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ABSTRACT

Tracing the historical emergence of academic/policy discourses shines a light on processes of early institutionalisation, informs narratives of contemporary self-identity and provides a resource from which to imagine alternative futures. Contributing to this ambition our paper uses scientometric methods to undertake two socio-semantic analyses. First, we identify the *de-facto* origins and contemporary clustering of scientists' discursive spaces of 'responsibility'. This 'rri corpus' reveals seven distinct clusters – or discourse coalitions of responsibility – but shows limited cross-fertilisation between the clusters. Second we trace the emergence of European policy on 'Responsible Research and Innovation' (RRI). The 'RRI corpus' shows policy to have been dominated by a small number of actors. Some cross-over between rri and RRI provides evidence of discourse coalition building, but only a small group of actors occupy these strategic bridges. The paper offers a contribution to wider debates and strategic reflections on the past, present and futures of responsible innovation.

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Introduction

In a recent article named '*Reinventing responsible innovation*', Erik Fisher calls for a redoubling of efforts to '*clarify, refine, redefine, or renew what counts as responsible innovation*' (Fisher 2020, 2). In 2018, similarly referring to what he called the 'European Commission's RRI Experiment', Fisher advocated '*taking stock of what can be learned ... what can be gained, what may need to be recovered, and what futures of responsible innovation should guide our conceptual, strategic and methodological efforts moving forward*' (Fisher 2018, 253). Fisher notes that '*changes in what counts as responsible innovation can be traced back to at least the 1970s*' (Fisher 2020, 2).

While we may query this date and advocate attention to a longer pre-history to appreciate the *de-facto* seeds and structuring of responsibility discourse(s), we share Fisher's interest in a project to develop a repository of historical accounts, as an aid to

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an organised self-reflection on the origins and development of discourses of scientific responsibility, from which to imagine, strategise, and shape alternative futures. Our contribution to such a project involves identifying seminal authors, tracing who says what about what, when and with reference to whom, and unpacking the content of prevailing topics, debates, controversies and struggles in and over time, using scientometric analysis.

Scientometrics is a science that produces its own reality, replete with seductive visualisations and maps. There is nothing natural or neutral about it. But the mapping exercises, when put to the service of interpreting histories, do provide a useful point of departure: inviting further questions, stimulating theoretical, empirical and indeed methodological explanation of the outputs, and offering opportunities to challenge, counter or corroborate the qualitative storyline of the originators of the analysis.

In this respect, the current paper does not stand alone. It shares the ambition of Shanley (2021) who seeks to (re)cover neglected, forgotten and emancipatory *anti*-histories to provide richer and more diverse accounts of R(R)I (to use Shanley's preferred acronym) than received established histories provide. Genealogical analysis, such as that presented in this paper, can likewise contribute to the probing of received histories and a questioning of what appears natural.

With these qualifications to the fore, for the current paper, we reconstructed an intellectual genealogy of the new discursive space of 'responsible research and innovation' on the basis of an abductive analysis (iterating empirical/theoretical investigations) of the academic literature. We first constructed what we will call our responsible research and innovation (or rri) corpus, generated by interrogating the Scopus database through key terms of responsibility: 'responsible research' or 'responsible innovation' before the composite phrases were coined. We do not aim to normatively define responsible research and innovation (Stilgoe, Owen, and Macnaghten 2013), nor take as a start point a particular definition of RRI (von Schomberg 2011, 2012, 2013). Rather, our approach complements the works of Burget, Bardone, and Pedaste (2017), Ribeiro, Smith, and Millar (2017) and Shanley (2021) who seek to recover the (neglected) history of concepts, actors, debates and delineations of what constitutes responsibility in research and innovation through qualitative approaches.¹

Through the lens of a complementary approach, we are equally motivated to understand the discursive emergence and genealogy of a policy domain explicitly labelled Responsible Research and Innovation (or RRI) within the European Commission's Horizon 2020 programme. We call this our RRI corpus. It is compiled through the analysis of documents sourced online through Google Scholar. Google Scholar enables the RRI corpus to include policy reports, academic contributions and commentaries from civil society actors, private consultancies and think-tanks, providing a much richer and more comprehensive capture of the role and significance of interventions from a broad spectrum of actors who may be influencing the discourse, than the rri corpus unveils.

The rri and RRI approaches are, therefore, not comparable and are not intended to be. In addition, the RRI analysis was supplemented by a series of qualitative interviews with nine former heads of units and key policy officers of the Directorate-General for Research and Innovation (conducted between April 2015 and May 2016) to add insight to our account of the historical emergence of RRI from the direct experiential accounts of

key actors who were involved in the development of RRI in Europe. A sister paper to this one (Macq, Tancoigne, and Strasser 2020) provides a more elaborated qualitative history of RRI than space permits in this paper.

The emergence of RRI is traced in terms of its historic and organisational siting, and its defining discursive elements. Indeed, we are motivated to understand the interconnections between rri and RRI. Do we find evidence of shared historical traditions, shared contemporary discourse, or shared epistemological and normative orientations among the RRI protagonists, compared to those revealed in the rri analysis?

Our paper, therefore, situates within the wider study of *de-facto* responsible innovation (inspired by the notion of *de-facto* governance, Rip 2010, 2018) from the methodological position of abductive inquiry into what actors say and do in the name of responsibility (rri) ‘in the wild’² rather than what we would prefer them to say and do according to our particular researcher and/or ‘top-down’ policy-derived normative frameworks (RRI) (Randles et al. 2016, 2014; Randles 2016).

More directly, the specific contribution we make in response to Fisher (2018, 2020) is to provide an account of the historical emergence of the intellectual field of responsible innovation.

The paper proceeds as follows. Section 2 reprises theoretical perspectives on the words/actor combinations in the formation of discourse coalitions. Section 3 acknowledges multiple and neglected histories of *de-facto* responsible innovation to provide a qualitative backdrop. Section 4 describes the methodology employed to generate the rri/RRI text analyses for this paper. Section 5 reports on findings from both the rri and RRI corpora and Section 6 discusses the implications of the findings. Section 7 concludes by offering our paper as one input to a wider project to gather a range of historical resources contributing to Fisher’s request to instigate a future-oriented conversation and strategic reflection on ‘*what counts as responsible innovation*’.

Discursive spaces, discourse coalitions and performativity in processes of institutionalisation

Discursive activities have manifold influences and effects. The power of words lies not only in the performativity of language – a typical situation where saying something is doing something – but covers a wide range of meanings related to sense making, issue framing, and the control of perception and interpretation of reality. The strong interactions that exist between words and power have been taken into account in various streams of analysis since the linguistic turn in social sciences, including public policy analysis (Bensaude-Vincent 2014; Fischer 2003).

The use of ‘responsibility’ in the area of research and innovation has a long track record. On one hand, scientific responsibility has a very long history made of many debates within and around the scientific community and some forms of institutionalisation: ethics committees, guidelines for ‘responsible conduct of research’. On the other hand, the expression ‘responsible innovation’ (Guston 2004; Hellström 2003) or related expressions such as ‘responsible development’, have taken off in the late 1990s only and appeared as a response to a series of crises (Owen, Macnaghten, and Stilgoe 2012). By contrast, the expression *responsible research and innovation*, whether in the academic or policy literature, as such is even more recent. ‘Responsibility’ has strong

evocative power and many meanings (Vincent 2011). It resonates with different concerns, and its interpretive flexibility is high (Bensaude-Vincent 2014). And yet, as the term has some political (and corporate) appeal, it may be used for mere re-labelling of existing practices, leading to a kind of ‘responsibility washing’ (Randles et al. 2014; Randles 2016; Randles et al. 2016). But, it may also contribute to the reinforcement of a new normative order, a new form of governmentality creating connections between separated areas of practice.

The attention devoted to the link between discourse and power is generally related to the linguistic turn in social sciences and more specifically to the crucial influence of Foucault. The basic point is that language ‘*profoundly shapes our view of the socio-political world rather than merely mirroring it*’ (Fischer 2003, 47). As suggested by Miller and Rose (1990), pointing out the role of language in government does not mean that the study of power equates to the history of ideas, but instead, we have to consider language as an intellectual technology that renders ‘*reality amenable to certain kinds of actions*’ (Miller and Rose 1990, 7). Discursive matrices embed political rationalities – a Foucauldian concept that points to the diverse ways to articulate the ends and means of government. Those matrices construe the objects of government, set the grammar of analysis and prescription, and provide the terms in which the legitimacy of government is established.

Among the diverse approaches for empirically grasping the links between discourse and power, two are of particular interest for our own analysis. In the field of science and technology policies, Pestre (2009) uses the notion of discursive regime to point to the ways through which the forms of government are promoted on a daily basis ‘*through words, new sets of notions and categories that define ontologies (what the world is made of) and values (the norms that should be used to guide us)*’ (Pestre 2009, 11). His claim is that a new discursive regime has emerged since the 70s, related to the neo-liberal governmentality, and marked by the frequent reference to governance, participation, civil society, greening, etc. The genealogical analysis allows to question what appears as natural and to highlight the processes through which the new regime stabilises and becomes effective although it may have been – and perhaps remains – contested.

Also referring to Foucault, other scholars adopt a more fine-tuned approach to discourse, which is attentive to the variety of discursive matrices. The approach of Hajer (1997) rests on the identification of storylines and discursive coalitions. A storyline is a ‘*generative sort of narrative that allows actors to draw upon various discursive categories to give meaning to specific or social phenomena*’ (Hajer 1997). A discourse coalition is the assemblage of a set of storylines – the actors who utter these storylines and the practices that conform to these storylines – all organised around a discourse. A discourse coalition can be said to dominate a given political realm only if it meets two conditions: (i) it dominates the discursive space: that is central actors are persuaded by or forced to accept the rhetorical power of a new discourse; and (ii) this is reflected in institutional practices: that is the actual policy process is conducted according to the ideas of a given discourse. By applying these approaches to the study of social responsibility of science, Glerup and Horst (2014) identify four different political rationalities that differ according to whether they advocate the internal or external regulation of science and whether they are focused on the regulation of the process or the outcomes of science (see also Arnaldi and Bianchi 2016).

Multiple, neglected and qualitative histories of de-facto responsible innovation

Whereas a general history of responsibility of research and innovation is still lacking, scientometric analysis serves-up intriguing representations of key moments and pathways in the historical emergence of responsibility discourses, which stimulate reflections on their theoretical and empirical explanation. However, illuminating scientometric outputs, juxtaposing a range of qualitative accounts of science/society relations provides a more critical and reflexive approach to the interpretation of historical storylines than a stand-alone dependence on the quasi-automatic methods like scientometrics affords. Triangulating the quantitative and qualitative methods enables a more robust interrogation of multiple histor(ies) than either on its own achieves. Intriguingly, our analysis confirms the sociologist Robert Merton as a seminal author influencing the development of natural and medical science discourses of responsibility, in particular, bioethics.

(Alternative) histories and pre-histories of responsible innovation

In fact, reaching considerably further back than Fisher (2020), Merton's (1935) doctoral dissertation: *'Science, Technology and Society'* came to typify Merton's empirical approach being to study the 'concrete research of scientists' (ibid: xvii); in this case, focussing on ballistics and weaponry research in late seventeenth century England. Empirical studies followed on military technology, mining and navigation, highlighting the non-trivial point that the 'concrete research of scientists' is always time-place situated, and reflects the 'practical problems' and policy imperatives of the time. Importantly, Merton extends and nuances the received wisdom of Michael Polanyi's (1946, 1962) *'Republic of Science'* thesis, which highlights the self-referencing, self-regulating, autonomy-oriented nature of scientific knowledge and values. To this, Merton layers a second institutional logic, which he finds to co-exist with the account of science as an autonomous self-referential institution. He, therefore, posits a dual logic, comprising simultaneously on the one hand, of a short-term time horizon where the everyday work of scientists is conditioned and regulated by a distinctive 'self-contained reward system of science' (ibid xxii). This is consistent with Polanyi's thesis of science as a self-regulated institution governed by scientists for scientists, free from external 'corrupting' influences of other groups and institutions of society. On the other hand, and evolving over a much longer arch (a long histories account), Merton found scientists responding to the 'practical problems of the time' determined externally, such as an external demand for research on weapons technology. The responsibility storyline of the time was one of protecting the empire. *De-facto* responsible innovation is not always pretty, indeed.

The significance of the above vignette is two-fold. First, most directly related to our paper is that quantitative metrics that analyses the words of only one group in society – such as scientists, in the case of Scopus database – can only provide a partial account of the formation of discourse coalitions. In the above example, there is an inference that the scientists in question do not have the self-regulating autonomy that Polanyi depicts. Rather, they are co-opted into the service of the state. This is not the contradiction that it at first appears. Indeed, it is entirely consistent with Hajer's two conditions

that the formation of discourse coalitions is an expression of uneven power relations. In this case, involving the sedimentation of two institutional logics: one of apparent internal self-governance, the other of powerful external control.

Second and more generally, studies that confront scientometrics with qualitative histories, which trace the role and relevance of a range of actors involved in scientific debates about responsibility, provide powerfully contrastive perspectives such as the ‘neglected histories’ of Shanley (2021).

Briefly bringing the case of weapons research into the twentieth century, the atomic age dawned in 1942 with the establishment of the Manhattan Project tasked with weaponising nuclear energy. In the post-war era, American scientists were celebrated for their contributions to social and technological progress even as the Manhattan Project was state-directed and managed by military personnel in the guise of Army Colonel Leslie R Groves, under the National Defence Research Committee. The Committee changed its name to the Office of Scientific Research and Development as the project officially morphed into a military initiative with scientists serving a supportive role. Much later into the 1960s, an organised anti-war opposition, led by younger scientists from inside and outside the government questioned the morality of using napalm and other non-nuclear weapons in the Vietnam war (Bridger 2015). Scientists then formed protest organisations, such as Science for the People and the Union of Concerned Scientists (Moore 2013), with the result that the relationship between government and science began to fray (Bridger 2015). According to Agar (2008), the sea-change which resulted in a weakening of the intimate relationship between the American scientists and the US government can be located in the ‘long 1960s’ against the backdrop of the Cold War period stretching from the mid 1950s to the mid 1970s. Over this 20-year-period, anti-war civil society movements joined forces with organised groups of young scientists opposing their own scientific establishment. Eventually, this new alliance of young scientists and civil society weakened the entrenched science/state relationship (Agar 2008), such that the role of scientists as counsellors to future presidents, as a consequence, diminished (Bridger 2015). These notes illustrate how a long(er) historical arch, supported by qualitative accounts tracing the breakdown and re-alignment of the most rigid of incumbent discourse coalitions, puts our rri and RRI analysis into the perspective of longer time horizons.

In other accounts, research illuminates the bureaucratic responses of administrators and managers to the policing of scientific integrity and fraud (Mody, Sibum, and Roberts 2020) and the interventions of Institutional Review Boards (IRBs), alongside lawyers, health departments and hospitals aligned against the National Institutes of Health in the USA, in a struggle over the stake to become the authoritative voice adjudicating ‘what it is to be human’ (Stark 2011). Scher and Kozłowska (2018) similarly draw attention to legitimacy challenges that came into play in the emergence and contestation of a consumer rights discourse on bioethics, as a rights-oriented position was argued through the courts, eventually giving legal force to the rights of patients against doctors. The purpose of enriching the current discussion with these accounts is to acknowledge the contribution that qualitative histories play in illuminating the particular moments and junctures of responsibility framing and discourse formation, bringing in from the wings, the contribution of a rich tapestry of actors, in the formation and breaking of discourse coalitions of scientific responsibility. The purpose is not to attempt

to provide a singular history of rri. Rather, we take the approach of introducing qualitative vignettes of rri to illustrate the essence of it, and to show that a multiplicity of actors participate in different, and differently contested, instantiations of rri.

RRI as a discursive space: the historical and organisational emergence of RRI in Europe

In contrast to the long history of rri, our history of RRI is notable for its rapid rise and sharp demise, as a cross-cutting policy strand within the European Commission's Framework Programme 8 (FP8) or H2020, 2014–2018. Since the late 90s, the European Commission (EC) has been very active in producing new discourses on science-society. Until the 4th Framework Programme (hereafter FP) (1994–1998), science and society activities were very marginal, mainly consisting of information and monitoring. FP5 (1998–2002) included a new action programme devoted to citizens' awareness. FP6 (2002–2006) was marked by the creation of the Science-Society Directorate and the launch of the *Science and Society* programme (88 M€, 0.5% of R&D budget). FP7 (2007–2013) extended this move and introduced the *Science in Society* label; with a budget that increased sharply (330 M€). H2020 (FP8 2014–2018) had a new label, *Science with and for Society* (SwafS) with a significantly increased budget (462 M€). In 2011, the label 'Responsible Research and Innovation (RRI)' was taken up by the Directorate-General (DG) Research of the European Commission and defined as a cross-cutting issue of the new EU Framework Programme for Research and Innovation Horizon 2020. RRI appeared as the centrepiece of the SwafS programme.

Schmidt (2008; 2010) and Schmidt and Radaelli (2004) have shown that the European Commission heavily draws on discourse framing as a way to overcome legitimacy deficit. Considering the changes in the Commission's discursive practices that led to RRI, one can distinguish 4 phases: public information; citizens' awareness; participation and governance; science in society (Felt 2010). These phases do not operate as a linear succession but as sedimentation; the discursive practices do not substitute each other but co-exist, which conducts to the growing complexity of the representation of science-society interactions. Interestingly, discursive practices are also characterised by four continuities: the grand narrative of world competition; the deficit model; the narrative of progress; and consensus as a positive value. RRI thus appears in a long sequence of production of institutional discourse that aims at reframing relations between science and society. It emerges in a context marked by two key master frames: a wide reflection on governance that took place in the aftermath of the mad-cow crisis; and the focus of European policies on innovation (Macq, Tancoigne, and Strasser 2020). Science-society interactions are important insofar that they contribute to the completion of the Lisbon Agenda, which operationalises the discourse of the 'Knowledge Society'.

In June 2010, the European Council adopted the agenda of the Europe 2020 strategy for growth and employment and the Commission launched its flagship « Innovation Union 2020 ». The DG 'Science and Research' was re-labelled DG 'Research, Innovation and Science'. The main drivers in the new context are innovation and societal challenges. In this context, RRI was designed as the best way to re-assemble the different activities that were previously performed under the label 'science in society' (Macq, Tancoigne, and Strasser 2020). A unit of the DG Research became in charge of mainstreaming

RRI. In parallel, the Commission funded a series of research and support activities projects³ with several objectives: further elaborating the RRI concept, identifying best practices, creating RRI tools, designing guidelines, and building a community of professionals. In short, this was an attempt at the top-down institutionalisation of RRI, when paradoxically, RRI is intended to be normatively premised on the bottom-up co-construction with citizens of the processes and outcomes of innovation as argued by Flink and Kaldewey (2018). Given the importance of the mobilisation of researchers as a means to elaborate RRI and foster changes of practices (Rip 2016), the analysis of papers produced by these communities of researchers is relevant for analysing the interaction between language and power.

Methodological design – a dual approach to cope with differently institutionalised norms of publishing and semantic analysis of rri and RRI

Our study of rri/RRI draws on the systematic use of textual analysis to provide a genealogical account of rri and RRI. First, we construct and analyse a large corpus of academic texts on scientific responsibility, the ‘rri’ corpus. We provide maps of the semantic landscape of scientific responsibility and its intellectual roots, as viewed through the lens of scientometric methods. The ‘rri’ corpus gathers academic articles sourced through the Scopus database whose content is close to the ideas of ‘responsible research’ and ‘responsible innovation’. As compared to the genealogical analysis performed by Pestre, we do not aim at characterising a new discursive regime, but we rather want to identify the multiple meanings of scientific responsibility. Whereas scholars have elaborated on the polysemy of responsibility (Reber and Pellé 2013; Vincent 2011) the originality of our approach lies in the systematic identification of meanings of scientific responsibility in use through the systematic analysis of the corpus of texts. The semantic landscape constitutes the universe of meaning which is implicitly referred to when one uses the term responsibility associated with research and/or innovation.

Second, we construct and analyse a corpus focused on RRI as such: the RRI corpus. The ‘RRI’ corpus by contrast gathers documents whose content includes the words ‘responsible research and innovation’, sourced within the ‘grey’ literature of policy documents and reports as well as academic articles sourced through the Google Scholar online search engine.

Both analyses followed an abductive approach which facilitates the construction and representation of the discursive space comprising key terms and actors as an iterative qualitative process for each corpus, respectively. However, the analytical steps used to interrogate each corpus differ markedly. This is due to a combination of different platforms used to source the documents and the markedly different volume of texts in each, such that a direct comparison across the two corpuses was not – and could not be – an objective of the study.

There follow three tables. The first two (Tables 1 and 2) list the procedural steps taken in creating and analysing the rri and the RRI corpora, respectively. Our aim in setting out the analysis in this form is to make the procedural steps of the analysis as transparent as possible. So, each lists the steps of database selection, search criteria and decisions, data analysis and factors that influence the mappings (column 1, Tables 1 and 2), provides a

Table 1. Procedural steps followed to gather and analyse the rri corpus.

Step	Justification	Description of the process	Implications
(1) Deciding the search terms: step 1/2	We aimed to gather a corpus of academic references to analyse them with a scientometric approach. The Web of Science and Scopus were the best databases available in terms of data richness and quality. We interrogated both databases with a series of keywords.	We searched for references with the following query: « 'responsible research' OR 'responsible innovation' OR ('rri' AND responsib*) ».	The rri corpus contains scientific references only. It also contains inherent time-lags. It has a cut-off date of March 2014, and therefore captures only the early history of rri as an emergent discursive space.
(2) Selecting the database	We evaluated the two databases to choose which one was the best to work with. We did not want to merge the two to have consistency across the data.	We compared the number of results obtained for both databases. The Web of Science reported 124 references while Scopus had 207. The overlap was 40% and documents specific to Scopus represented 47% of the total references. We chose to keep the Scopus corpus.	Only 29 documents that were specific to the Web of Science were not included in the corpus.
(3) Corpus enlargement	We sought to enlarge this initial corpus to get a picture of the scientific landscape of responsibility in research and innovation. Numerous procedures have been developed to enlarge an initial corpus. They mostly consist either in (1) broadening the list of keywords used to search on the database, or (2) following the cited references and citing references of the initial corpus, (3) mixing both approaches. We chose to increase our initial corpus through a step-by-step introduction of new terms in our initial search expression.	We extracted each term related to the theme of responsibility in research and innovation in the initial Scopus corpus. We gathered the terms in five groups: (1) terms close to the term 'responsible research and innovation', (2) ethics, (3) research integrity, (4) (innovation and technology) impact, (5) (innovation and technology) risks.	The process was iterative and therefore influences the analysis.
(4) Deciding the search terms: step 2/2	We selected some of the terms previously found to enlarge our list of search terms and perform a new search on Scopus.	For reading purposes, we chose to include in our final query each and every term that gathered between 100 and 2000 references in step (3). See Table 3 for the details of the final query.	Each of the five previous groups of words identified in step (3) was represented.
(5) Co-citation mapping	This type of analysis is instrumental for positioning 'responsible innovation' in the wider more diverse semantic landscape of scientific responsibility and governance of new and emergent technologies. By systematically measuring distances between citations shared within an article, it detects clusters and identifies their historical origin.	We created a map based on the co-citation occurrences of the corpus gathered in step (4)(See Figure 1).	The co-citation analysis provides a visualisation of references cited by others, and captures only the most cited references. It, therefore, favours older references where a citation trail has accumulated. Moreover, a threshold has to be set regarding the number of citations displayed. For readability purposes, the map is limited to the citations that appear at least 7 times in the corpus.

(Continued)

Table 1. Continued.

Step	Justification	Description of the process	Implications
(6) Co-word mapping	This approach is similar to the previous one except that the map produced is not based on the co-citations but on the main terms present in the Title, Keyword and Abstract fields. It is not historical.	We created a map based on the co-word occurrences of the main terms of the corpus built in step (4)(See Figure 2).	A threshold has to be set on the number of terms displayed. For readability purposes, the map is limited to the terms that appear at least 10 times in the corpus.

justification for each step and clarifies the data manipulation carried out by the researcher (column 2, [Tables 1](#) and [2](#)), and summarises the implications of doing it the way we did – including showing the influence of the researchers’ decisions and the technical tools employed, on the analysis. [Table 3](#) compares the key dimensions of each corpus to highlight their differences.

Findings

Here, we report the findings of the socio-semantic analysis of the rri and RRI corpora. Analysing the rri corpus first, we find seven distinct, co-existing clusters of scientists/responsibility framings, with limited cross-linking between them. In the language of discourse coalition theory, these can be interpreted as separate discourse coalitions, comprising distinct groups of scientists, each associated with a particular responsibility framing or ‘storyline’. Interestingly, the branch within which STS scholars provide the step-off point for a new line labelled Responsible Innovation, is dwarfed by the clusters occupied by natural scientists. In terms of the much smaller RRI corpus, we find a more coherent and developed discussion of what constitutes ‘responsible *innovation*’ than we do in the rri corpus. However, only a small group of core individuals appears in both the rri and the RRI corpora, suggesting some academia/policy coalition building activity, but less inter-penetration of rri/RRI than we might expect.

Analysing the ‘rri’ corpus

The analysis of the rri corpus was performed in two complementary steps. The first is based on co-citations analysis and the second on co-word analysis.

Morphology of the co-citation landscape of scientific responsibility

Co-citation analysis is a scientometric tool used to visualise distinct domains of research. The co-citation analysis undertaken on the rri corpus ([Figure 1](#)) starkly highlights the main finding of this paper: namely, the fragmentation of the discourse on scientific responsibility, shown as three distinct and differentiated pathways.⁴ As [Figure 1](#) shows, distinct discourses deal with (i) scientific (mal)practice, responsible conduct of research and ethics (clusters 1–5) (ii) technological development, technology assessment (cluster 6) and (iii) the management of technological risk and risk perception (cluster 7). The two later clusters adopt a consequentialist meaning of responsibility whereas clusters 1–5 relate to the internal norms of deontology. Cluster 6 (and to a lesser extent cluster 7)

Table 2. Procedural steps followed to gather and analyse the RRI corpus.

Step	Justification	Description of the process	Implications
(1) Selecting the database	Google Scholar is the best available source for 'cross-over' literature: policy briefings, discussion papers, and other 'grey literature'. Google Scholar is also more likely to reveal new and recent academic texts. Access to new texts was an important criterion for the study of a new and fast-emerging field like RRI.	We chose to work with Google Scholar.	
(2) Search on Google Scholar	We searched for literature exclusively dedicated to RRI.	We searched for the exact expression 'responsible research and innovation'. It brought 548 references.	The RRI corpus contains inherent time-lags. It has a cut-off date of April 2014, and therefore captures only the early history of rri as an emergent discursive space.
(3) Filtering the corpus: step 1/2	A decision was made to exclude the references that were considered off-topic and the duplicated references.	All the references without 'responsible research and innovation' in their title, abstract or keywords were excluded. Most of these references were references that were found next to a RRI article on publishers' website and therefore considered by Google Scholar as related to the topic.	The corpus was narrowed to 107 references (20%).
(4) Searching for full text	The list of references was not enough to perform content analysis so we searched for their full text.	We gathered the PDFs through online research and emails to authors.	The corpus was narrowed to 97 documents. Missing documents were mostly on-going thesis or conference work.
(4) Analysing authors' profiles	We searched for demographical data on the authors: city of employment, whether they work at the European Commission (EC), are academics, participate in projects funded by the EC, have functions related to national or European science policy.	The research was done online through their personal webpages and social media accounts. We considered authorship in a broad sense since acknowledged contributors were also taken into account.	
(5) Graph of citations	We aimed to understand which were the key authors cited within the corpus to define RRI.	We coded the authors quoted to provide a definition of RRI in the documents. The network of authors quoted was then graphically represented (see Figure 3).	79 documents out of 97 provided a quotation when they first use the term RRI.
(6) Filtering the corpus: step 2/2	Most of the remaining texts mentioned the term as an element of context or introduction without engaging with it, e.g. developing or extending the concept. We filtered them so as to keep only the articles that elaborate on RRI.	We classified the documents according to the amount of content dedicated to RRI. We created three categories: <i>discussed</i> , <i>used</i> and <i>mentioned</i> . <i>Discussed</i> means that the reference contains reflections about the concept itself; <i>used</i> means that it is discussed but does not constitute the centre of the article, <i>mentioned</i> means	The corpus was narrowed to 27 documents.

(Continued)

Table 2. Continued.

Step	Justification	Description of the process	Implications
(7) Coding procedure to identify the discursive space of RRI	We defined three relevant dimensions of the discursive space through an abductive methodology that rested on several iterations between analysis of the corpus and formulation of dimensions stemming from the literature on RRI.	that it is a contextual element or that it is mentioned without further elaboration. We kept only the documents that elaborate on the concept itself (<i>discussed</i>). We started the coding process with dimensions extracted from the literature (Owen, Macnaghten, and Stilgoe 2012; Reber and Pellé 2013; de Saille 2013; Randles et al. 2016). We then reworked the categories while coding, through an iterative process. The two first final dimensions are related to the classical dichotomy process vs. product (governance vs. goals): (1) Types of governance of research and innovation (process): self-governance of research and innovators vs. new regulatory State; (2) Major goals of RRI (product): need of a paradigm change to address grand challenges vs. foster acceptance of new technologies. The third dimension is related to the meaning given to 'responsibility': (3) Meaning of responsibility: retrospective account (accountability, liability) vs. future oriented responsibility.	

Table 3. Characteristics of the two corpuses.

Corpus Source	rri corpus Scopus	RRI corpus Google Scholar
Query: Key Terms (cf. Appendix A)	'responsible research' OR 'responsible innovation' OR ('RRI' AND responsib*) OR 'responsible development' OR 'ethics in research' OR (('ELSA' OR 'ELSI') and 'ethic*') OR 'responsible conduct of research' OR (RCR AND responsib*) OR 'research integrity' OR 'scientific integrity' OR 'scientific misconduct' OR 'research misconduct' OR 'broad* impact*' OR 'technolog* risk	'responsible research and innovation'
Time span	up to March 13, 2014	up to April 15, 2014
Retrieved references	4,585	548
Relevant references	4,585	27
Analysis	Description of socio-semantic networks	Coding of discursive dimensions
Aim	Identifying the intellectual roots & discursive space of rri	Identifying the discursive space of RRI
Software	Cortex manager	Nvivo

is strongly related to the sociology of science and science and technology studies (STS). Both are linked to the issue of responsible governance of emerging technologies within which sits responsible innovation.

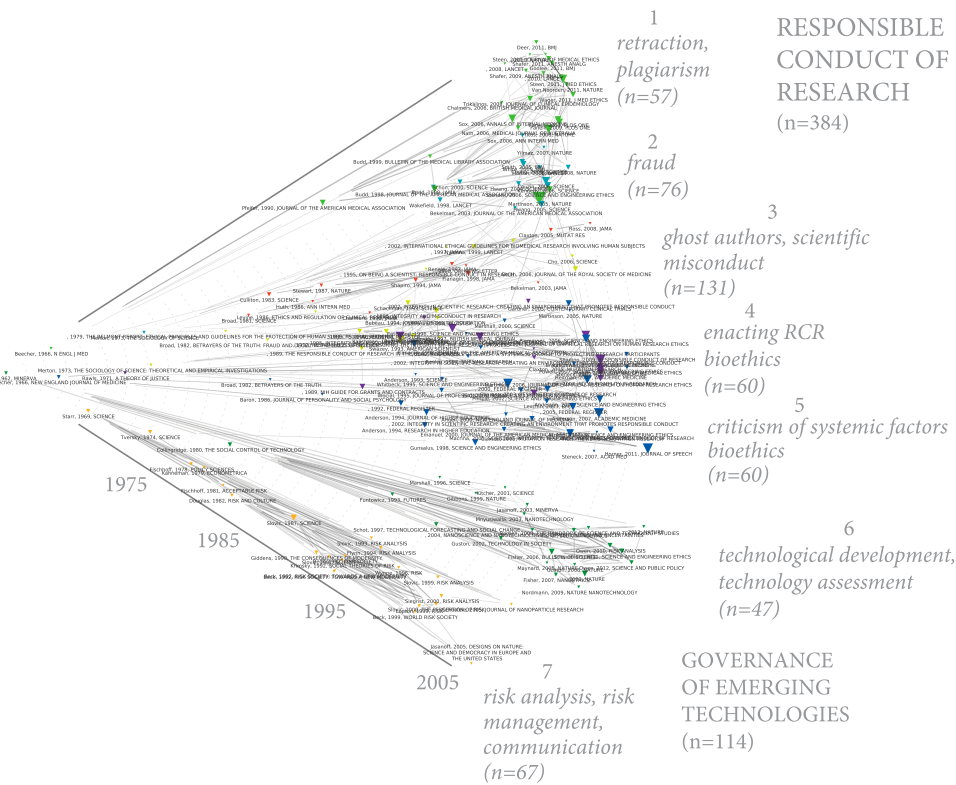


Figure 1. Three main strands of research deal with the notions of research and innovation responsibilities. Distinct discourses deal with (i) scientific (mal)practice, responsible conduct of research and ethics (ii) management of risk and risk perception and (iii) the sociology of science and technology studies, governance of emerging technologies and responsible innovation.

Notes: Co-citation network of the references that are used at least seven times in the corpus ($n = 179$). Measure: distributional. Edge filtering: threshold = 0.24. Clustering: Louvain. Chi2 measure of top three associated author’s keywords. Node size set according to the node’s number of links. Citations displayed according to a timeline (older citations on the left).

The co-citation analysis also allows us to identify the intellectual traditions associated with the different branches of the discourse. Pathways are computed according to the networks of co-citations.

At the top, pathway 1, contains six connected branches related to scientific (mal)practice, and its proposed (internal) correction mechanisms to restore trust in the scientific establishment, ranging from advocating frameworks for the responsible conduct of research to ethics and deontology approaches. The terms associated with these six pathways (at the right side of the figure, automatically computed by the software according to specificity measures) show the importance of the understanding of research responsibility as the self-regulation of research activities: scientific misconduct such as fraud, restoring scientific integrity, introducing mentoring etc. One can distinguish an upper branch (clusters 1 & 2) that shares early publications (Beecher (1966) and the Belmont Report (1979), thus a rather recent branch), on ethics in publication (peer-review guidelines, plagiarism, retraction and fraud). A close but older branch (cluster 3) is concerned with the value of authorship in publication, denouncing the existence of ‘ghost’ and ‘honorary’

authors. It then comes (cluster 4, 5) to ethics, and specifically bioethics and the training of students as apprentice scientists, and advocates approaches to ensure improved and transparent research practices under the rubric of responsible conduct of research. Here, notable references trace to the father of sociology of science, Robert Merton, who first theorised science as a political and historically located social institution based on the studies of research and technology development, in the West in the mid-1930s (Merton 1973); and the theorist and philosopher of distributed justice, John Rawls (1971). Interestingly, the explicit normative commitments of these founding scholars, who in turn provide the intellectual roots for contemporary (predominantly natural science authors), suggest a recognition by the natural sciences, that the scientific enterprise comprises a set of practices governed by social norms and rules, which are fallible and sit far from a myth of normative neutrality.

Pathway 2 (Figure 1, cluster 7) shows that the discourse on risk is related to an intellectual legacy that is very consistent. It gathers a lineage of authors that are well-known in risk studies, beginning with Starr's algorithms of perceived risk-benefit analysis asserting that risk-perception can be predicted and managed (Starr 1969), but also social theories of risk and uncertainty (Douglas and Wildavsky 1983; Fischhoff et al. 1981) and critiques of modernity (Beck 1992; Giddens 1990). Within this pathway, and overlapping with pathway 3, we see the origins of a normative call to widen participation in technology governance processes (Beck 1992).

The pathway from which the term 'responsible innovation' emerges (Pathway 3, cluster 6) is very specific and very recent, arising only in the 1990s and clustering from the 2000s onwards. It shows semantic origins in the words 'governance' with a specific future orientation (Funtowicz and Ravetz 1993; Schot and Rip 1997) and focuses on technology-society relations (Guston and Sarewitz 2002). It leans heavily on specific substantive technology domains namely nanotechnology, ICT and engineering. It traces back to some old references such as Michael Polanyi (1962) *The Republic of Science* and David Collingridge (1980) *The Social Control of Technology*, two authors who have raised the question of science and technology governance in very different ways. The other references are post-1990 and include (among other) issues related to the role of the public (Funtowicz and Ravetz 1993; Schot and Rip 1997), to the recasting of relations between science, society and democracy (Jasanoff 2003; Kitcher 2001), to the governance of science and technology (Gibbons 1999; Guston and Sarewitz 2002), to the responsible development of research (Nordmann and Rip 2009). Interestingly, most of the recent authors quoted belong to the STS field, which indicates the central role of this (relatively small) community in providing the epistemic and normative base and competencies for the conceptualisation of that field which they self-identified as *responsible innovation*. The presence of Owen in this stream (Owen and Goldberg 2010) is particularly notable since Richard Owen is the (only) author from this stream who (also) appears as a key author in the RRI corpus, providing an indication of effective boundary-crossing and intersectional work (Bowker et al. 2015; Star and Griesemer 1989) between the very different social worlds of academia and policy. It is also interesting that the citation lineage that constructs the pathway in which the term 'responsible innovation' emerges, makes no prior reference to innovation as a theme or topic at all.

Morphology of the semantic landscape of scientific responsibility

Turning to Figure 2, we present the results of the co-word analysis performed on the terms extracted from the Titles and Abstracts of the rri corpus. The findings complement and reinforce the citation analysis above, revealing two ‘meta-frames’ and seven ‘sub-frames’ in the socio-semantic mapping of the rri corpus.

Responsibility in the academic literature in Figure 2 divides into two distinct branches. The first, which still dwarfs the second in terms of volume of articles and authorships, is

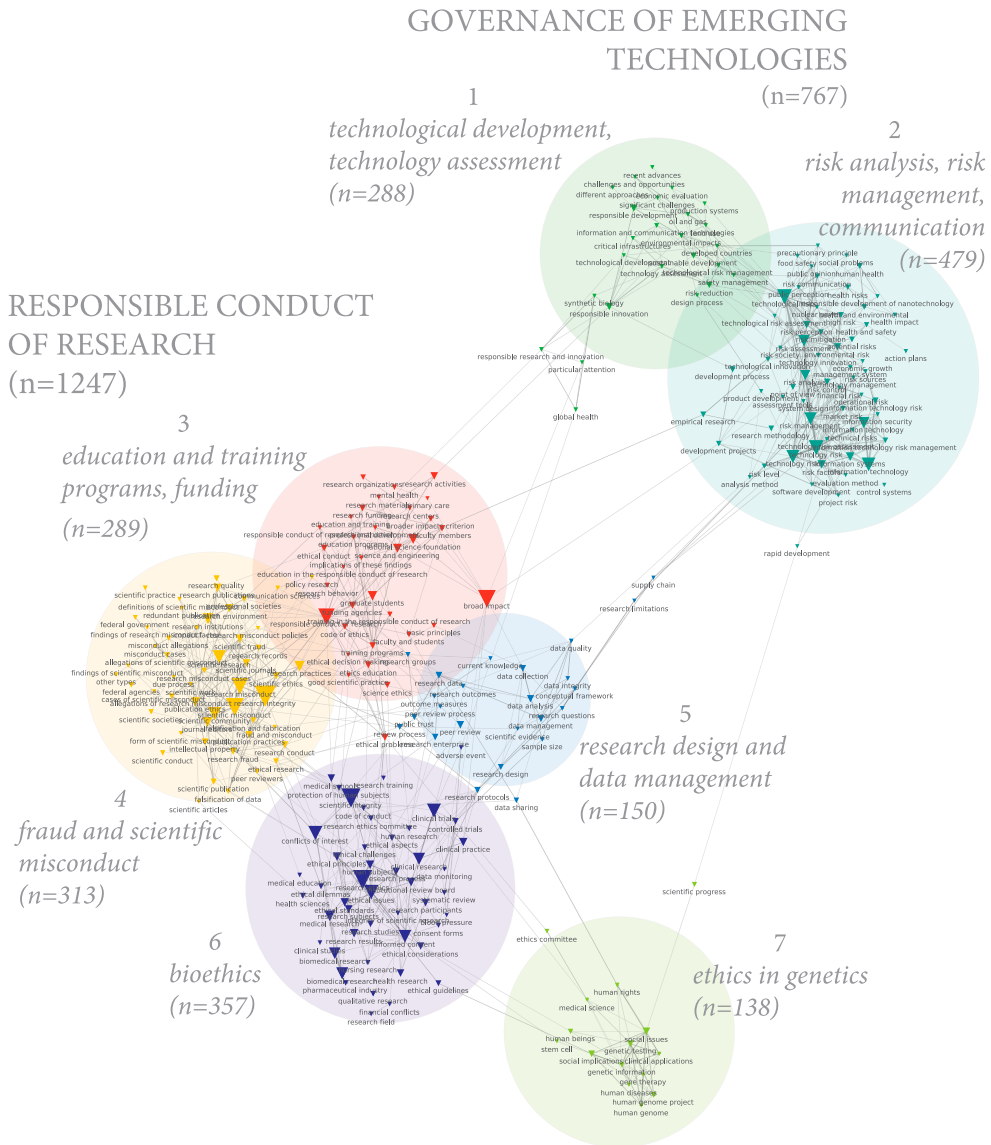


Figure 2. Two main topics and seven subtopics describe the academic discourse on scientific responsibility: innovation governance and ethics/deontology.

Notes: Co-occurrence of Abstract and Title terms used at least ten times in the corpus (n = 276). Measure distributional. Edge filtering: threshold = 0.31. Louvain clustering. Node size set according to the node’s number of links. Color circles size set according to the number of links.

dominated by articles in science, nature and other natural, physical and medical science journals. It refers to discussions about *scientific integrity and responsible conduct of research*. It is formed of five interconnected clusters (clusters 3–7). Clusters 3 and 4 gather questions around *responsible conduct of research* (RCR): fraud and scientific misconduct (cluster 4) and education and training programmes (cluster 3). Cluster 6 deals with bioethical questions (*code of conduct, protection of human subjects, clinical practice, informed consent biomedical research, conflicts of interest, etc.*). The training and bioethical clusters are both linked with a cluster on research design and data management (cluster 5). A smaller and more isolated cluster (cluster 7) deals with *ethics in genetics*.

We observe little cross-fertilisation between the two meta-discourses. The first has a much longer lineage, and we can associate it with more deeply structured rule-like practices, protocols and incentives with authors responding to a common external environment around which is constituted the meaning and shared understandings of appropriate and correct behaviour of practicing scientists (DiMaggio and Powell 1983; Meyer and Rowan 1977; Meyer and Scott 1983; Zucker 1983; Randles 2016; Owen et al. 2021). Dominated by contributions from natural and medical sciences, this meta-discourse reflects the need to restore trust in the scientific enterprise after a number of high-profile cases of scientific malpractice in the 1960s. This was the price to pay to maintain the advantages of self-regulation. The internal debate on ethics and deontology conducted new measures which demonstrated heightened standards of vigilance and oversight. This led to the introduction of new formal protocols such as ethics reviews, ethics committees and new formalised curricula for the training and professionalisation of young scientists. In this section of the rri corpus, texts are generally oriented to correcting misbehaviour within their own ranks around plagiarism and fraud, and alternatively creating a positive outlook around research integrity, ethics and open-access data. It points to a highly self-referential and technocratic system logic. The longitudinal analysis (Figure 1) shows that this branch is still publishing in the late 2000s, suggesting relative stability. In the later period, the branch co-exists with newer discourses of responsibility.

The analysis confirms a second, much smaller meta-framing, distinct and largely separated from the first and the preserve of social sciences and humanities scholars (clusters 1–2). It encapsulates the *sociology of science and STS, risk assessment and governance of emerging technologies*. It comprises two overlapping sub-clusters, a first, much larger and with earlier lineage on *risk analysis and risk perception* (cluster 2). It deals with risk analysis, risk management, communication, etc. Risk is associated with innovation and technology: *technological innovation, technological risks, technology innovation, technology risk, etc.* The *precautionary principle* is mentioned and it is associated with *food safety, human health, and public perception of risks*, one of the biggest nodes of the cluster. The second, much smaller adjacent sub-cluster (cluster 1) overlaps the ‘risk’ cluster and reveals authorships from STS scholars from where the specific term ‘responsible innovation’ emerges within the discursive space we have labelled the *responsible governance of new and emerging technologies*. This is our cluster of most direct interest as it is where we see terms: *responsible research and innovation, responsible innovation, responsible development, education programmes, global health, synthetic biology and technological development*.

Thus, both co-words and co-citation analyses depict a fragmented landscape of research on responsibility in research and innovation. The European Commission

policy RRI stems from a very specific sub-branch of this landscape. In the next section, we analyse its discursive space.

RRI as a discursive space

The take-off of RRI starts in 2011 with European Commission Officer René Von Schomberg’s and consultant Hilary Sutcliffe’s reports for DG Research and Innovation (von Schomberg 2011; Sutcliffe 2011). Most of the 79 Google Scholar documents that provide a background for RRI refer either to these texts or innovation scholar Richard Owen (See the network of citations in Figure 3), with R. von Schomberg as the most prominent source of citations.⁵

Most of the authors (80%) published only once on RRI. Few authors who regularly publish on RRI are either highly connected to an EC context (R. von Schomberg) or have long been involved in EU-research projects (B.C. Stahl et al., D. Robinson). When we consider the 27 core documents (that make a substantial contribution on RRI) and their 38 authors, 85% of the authors belong to institutions located in Europe. Interestingly, half of them were involved in FP7 projects and a third occupy functions related to national or European science policy.

Based on this corpus, we analyse the discursive space of RRI. This space, we suggest, is structured by three different dimensions. Two of these dimensions are adapted from Glerup and Horst (2014), namely: *governance* [self-regulation (soft law) versus the

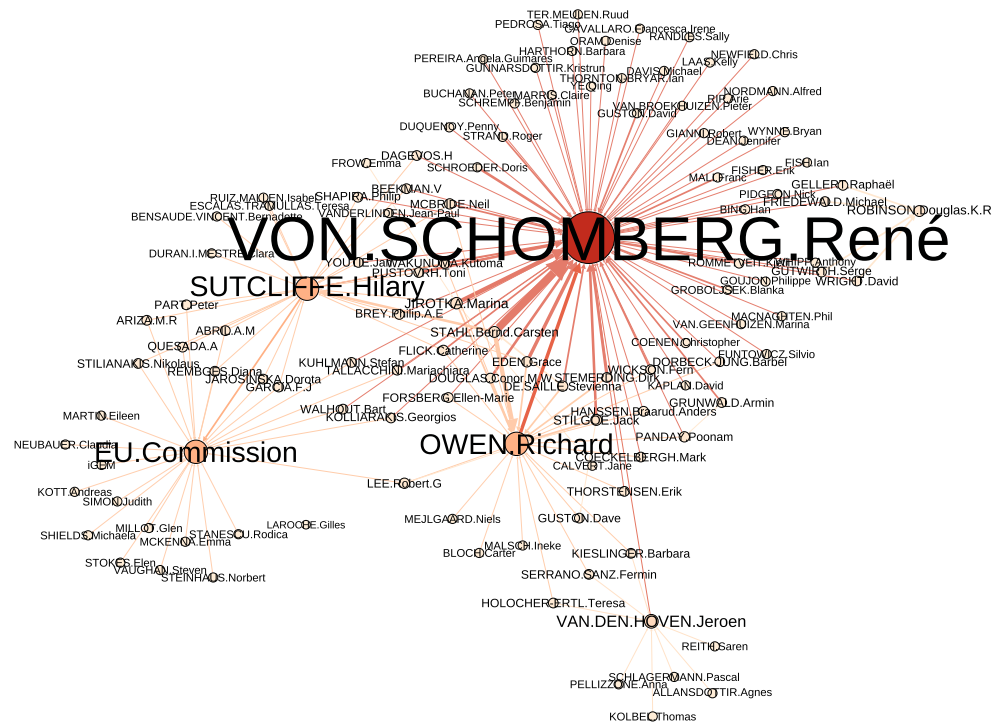


Figure 3. A graph showing which authors are cited by whom when it comes to defining RRI (data from the RRI corpus). The size of the nodes is proportional to the number of citing authors.

strong role of government (legally binding measures)] and *meaning of responsibility* (prospective versus retrospective as suggested by Owen, Macnaghten, and Stilgoe (2012)). The third dimension refers to the *goal of research and innovation* (grand challenges versus competitiveness for goals). Its relevance is related to the growing debate on innovation, both in the academic and policy arenas (Joly 2019).

Governance. Discourses on governance are generally about issues related to new emerging sciences and technologies in a globalizing world. The emphasis is put on uncertainty and unpredictability as well as on the difficulties to define the rules of a global game. Many of the papers mention the importance of soft law (16/27) because of its supposed flexibility and responsiveness (#13-4).⁶ The most cited tool for RRI governance is the ‘Codes of Conduct’ (9/27), presented as adapted for steering innovation process in the contexts of radical uncertainty, with numerous references to The European Commission Code of Conduct for Nanotechnology. Governance is characterised as neo-corporatist (#4-2), meaning that the capacity of governments to control and steer the process is considered to be low. As public authorities are considered to have a problem of timely access to relevant information, a key role is attributed to knowledgeable actors – ‘experts’ - in research and innovation.

Finally, RRI is generally considered as a dialogical process with two complementary dimensions: public engagement and interdisciplinary dialogue. Public engagement is presented as a response to citizens’ claim for democratic participation. It is not about fostering acceptance, but aiming at deliberating on the objectives of research and innovation. Opening up research and promoting responsibility would also depend on the development of interdisciplinary approaches, particularly on the embedment of social scientists in research projects.

In comparison with the discursive frames and coalitions identified in the rri corpus, the RRI stream focuses more strongly on the governance of *innovation*. The texts share a representation of innovation as an interactive and transformative process, which has to be opened to a variety of actors, well beyond scientists: stakeholders, the general public, users, consumers, etc. This representation originates from research in STS, but also studies of policies for research and innovation (SPRI) that gained political influence in the late 90s (Macq, Tancoigne, and Strasser 2020). The participatory discourse on research and innovation governance is at the core of the European H2020 framework programme.

Main goals. The goals of RRI are more diverse and ambivalent. On the one hand, the texts point to the need to foster the acceptability (and desirability) of new technologies (5/27), thus a concern that RRI should not be detrimental to competitiveness and economic growth. On the other hand, some texts refer to the need for RRI to better address societal challenges and help to adopt approaches to research and innovation that go beyond the competitive frame and address inequalities within Europe.

Because of such internal contradictions, some authors (5/27) warn about the danger for RRI to be just a way to do ‘business-as-usual’ and follow the same trajectory as ‘sustainable development’.

This discourse of RRI is also very distant from earlier discourses on scientific responsibility, since it raises the issue of the *goals* of research upfront. This is obviously related to the central place devoted to innovation, which takes into account socio-political transformations related to the outcomes of innovation seriously. This was not generally the case for earlier generations of scientific responsibility. The texts of the RRI corpus are

aligned with the European discourse of knowledge economy and with the discourse of H2020 that points out the need to orient research and innovation to the teleological (means/ends) focus of addressing societal challenges, as determined by the European Commission.

Meanings of responsibility. The authors of texts on RRI are fully aware of the traditional definitions of responsibility (7/27). Several authors remind that responsibility is determined by an act of attribution of an outcome to an actor and quote philosophers that have approached responsibility in this way. However, when it comes to RRI, retrospective responsibility, when mentioned (12/27) is generally dismissed and prospective responsibility is considered a much-preferred interpretation. Hence, there is a general consensus on the following definition of responsibility related to RRI: prospective rather than retrospective, ethical rather than legal, and collective rather than individual (#15-M1). The justification is that responsibility for innovation outcomes is distributed in a network of actors that interact intensively and contribute to the creation of innovation and new technologies. It is also considered to be about achieving societal goals, not preventing negative externalities, and therefore becomes a matter of responsiveness, care, and anticipation.

There are many meanings of responsibility as claimed by different authors, including Nicole Vincent who proposed a comprehensive structured taxonomy of responsibility (Vincent 2011). In this context, one may be surprised by the relatively high convergence of the use of the concept. The emphasis on the collective and prospective dimensions of responsibilities is pervasive in the corpus. Responsibility is less a matter of liability and accountability than a matter of care, responsiveness, and anticipation. It is less a matter of avoiding hazards and unintended consequences than failing to develop solutions to address critical societal challenges.

Discussion

Our analysis shows that ‘responsibility’ is applied in a highly flexible way. Within a wider semantic landscape, this flexibility manifests as diversity in semantic usage and the actors involved. The analysis of the ‘rri’ corpus shows that, although scientific responsibility is an old and institutionalised discourse (with its actors, organisations, competencies, training programmes, etc.) responsible innovation differentiates from other streams, both in terms of semantic network and intellectual tradition. Here, it is not the practice of scientific research as such that is at stake, but instead, its implications (positive and negative) for society. It is not only about controlling adverse effects but also about a broader appraisal of the transformative effects of science and technology. It is interesting that in terms of their temporal development, pathways 1, 2 and 3 do not show evidence of competitive displacement of one discourse coalition for another. We find no evidence of the ‘de-institutionalisation’ (Dacin and Dacin 2017) of antecedent discourses nor their associated actors. Rather, we see a pattern of sedimentation as new discourses, authors, theories of ‘responsibility’ and normative positions emerge, each with different implications for practice overlaying antecedents, leaving the original intact and apparently untouched by the ‘new kid(s) on the block’. This raises questions of ‘responsibility overload’ when translated into implications for practice (Randles et al. 2014; Randles 2016; Randles et al. 2016). Linked to this point, the findings confirm

‘responsible innovation’ as a new term and discourse firmly rooted in the scholarship of the STS community. An important question for the future of this emergent field is whether, how and what could be strategically gained (or lost) by increasing the number and depth of co-authorship connections across the different clusters of this broader landscape, by forging new inter-disciplinary research collaborations and co-authorships bridging the existing pathways, seeking to enlarge the nascent field of responsible innovation. For example, considering the distance between the discourse coalitions of these two meta-frames depicted in [Figure 2](#), and the lack of cross-linkages connecting them, the analysis suggests that if inter-disciplinarity between natural and social scientists is a goal or ambition of responsible innovation, it is not yet evident in this early scientometric analysis.

Turning to RRI, we identify one dominant and relatively coherent position in the discursive matrix. First, RRI framing is about research and innovation outputs and goals, taking seriously the desire to *steer* research and innovation towards solving societal problems, in particular, so-called ‘grand’ challenges (Robinson, Simone, and Mazzonetto 2021). Second, RRI framing refers to the inclusive and participative forms of governance, and thus, differentiates it starkly from discourses premised on the self-regulation of science by scientists. Third, the meaning of responsibility embedded in RRI is prospective rather than retrospective, moral rather than legal, and collective rather than individual. The main continuity is related to the conception of participatory governance; the main novelty is the acknowledgement of the need to steer research and innovation toward desirable goals. This echoes the discourse on great societal challenges and it translates in the understanding of responsibility as oriented toward the future.

This analysis raises several questions. First, the future of a distinctive field labelled responsible innovation does not only depend on dynamics within the discursive space, but also on the possible relations with earlier and currently co-existing discourses of responsibility. Questions related to ethics, deontology or risk management might be reframed within responsible innovation as a larger paradigm. The same is relevant for Technology Assessment (TA). As claimed in the PACITA Manifesto, RRI ‘has given key concepts in TA, such as participation, forward-thinking, reflexivity and policy action, greater focus’.⁷ However, TA scholars are not keen on this apparent co-optive move.⁸ Another opportunity to bridge the discourse coalitions of *de-facto* rri and respective communities is through the greater collaboration of social and natural scientists bringing reflections on what constitutes responsible innovation to a new generation of scientists. Recovering the significance of histor(ies) of science within early-career training curricula would aim to nurture a reflective appreciation of the merits of inter- and multi-disciplinarity, at an early stage in the formation of social and natural scientists of new and emerging technologies. Our combined approaches lead to draw attention to the plural and political nature of *de-facto* rri/RRI. A suitable organisational setting for such a reflection would be the responsible innovation components of multi-disciplinary doctoral and early career training programmes, for researchers of emergent science, technology and innovation. This ambition is already underway in many countries.⁹

Further, the coalition attached to the *responsible innovation* discourse within the rri corpus includes social scientists, a small group of European Commission Officers involved in the science/society field, and some consultants. A high number of the academic authors within this corpus worked on recently commissioned European

Commission H2020 projects (and before them, FP6 and FP7 projects). The analysis confirms, therefore, that the responsible innovation community, up to 2014 at least, comprises a relatively small discourse coalition with its disciplinary heartland in STS, and shows limited reach-out to form strategic bridges with other coalitions and disciplines, yet the significance of the individuals where bridging between rri and RRI *does* occur may reflect a situation of the strength of weak ties.

However, particularly significant, surprising and puzzling is the apparent absence of linkages between this STS community, and cognates within innovation studies that share the normative premises and values of rri/RRI. We might, for example, expect to see shared intellectual heritage with grass-roots innovation (Stirling 2019), transformative innovation (Marshall and Dolley 2019), and recently, ‘just’ innovation’ (Ludwig and Macnaghten 2020). The paradoxical absence of linkages to early cognate branches of innovation studies by a field that self-identifies as responsible *innovation* has been conjectured (e.g. Owen and Pansera 2019). Our paper provides empirical evidence to support their point.

A central finding of the scientometric analysis is the remarkably rapid upswing of texts on rri/ RRI in the academic and (European) policy literature alike, commencing as recently as 2011. We can compare this sudden and rapid take-off of rri/RRI, to the much more gradual development of another concept of social responsibility, that of Corporate Social Responsibility (CSR). CSR began as an academic discourse in the 1950s, with a more gradual uplift as the concept diffused into commercial practice as a driver (internally imposed) to extend voluntary self-regulation in the face of the perceived threat (externally imposed) of extensions in state regulation (Campbell 2007). But CSR took five decades to institutionalise (Carroll 1999). By contrast, the rapid upswing of rri and rise of RRI under the EC’s Horizon2020 programme – followed by its equally rapid dilution under Horizon Europe deserves attention in terms of a better understanding of how institutionalisation processes of RRI – were hindered.

Contributions

Randles: secured funding, designed the research, theorisation, article positioning and led the paper writing.

Tancoigne: designed the research, undertook data capture and analysis and paper writing.

Joly: secured funding, designed the research, theorisation and paper writing.

Notes

1. A recent and important addition to these efforts is the assessment by Wiarda et al. (2021), which combines qualitative as well as quantitative analysis, locates the historical foundations RI and RRI in sixteenth century writers, and finds bibliometric evidence that RI/RRI “has matured into an interconnected research trajectory.
2. With thanks to an anonymous reviewer who coined this term.
3. This work benefitted from such funding through the Res-AGorA project. Its aim was to develop a governance framework for Responsible Research and Innovation (RRI) (see the ‘Funding details’ section). Res-AGorA was one out of five projects specifically focusing on RRI in the EU’s 7th framework programme

4. Co-citation network of the references that are used at least seven times in the corpus ($n = 179$). Measure: distributional. Edge filtering: threshold = 0.24. Clustering: Louvain. Chi² measure of top three associated author's keywords. Node size set according to the node's number of links. Citations displayed according to a timeline (older citations on the left).
5. Interestingly, R. Owen and R. von Schomberg, together with P. MacNaghten, have recently published a paper in this journal. They provide an account of RRI in Europe as an ungoing but unfinished journey.
6. The first number of the code refers to the text, the second to the part of the text selected. List of texts is in Appendix B.
7. <https://www.pacitaproject.eu/ta-manifesto/>
8. Recent intra-tribal discursive struggles involving scholars representing RRI *versus* the earlier established academic and policy community practicing and advocating for Technology Assessment (TA) are indicative of new struggles - on one side to enrol TA into RRI, and on the other to prevent such a move. See Nentwich (2017) and Delvenne (2017) who advocate 'For TA' in response to van Lente, Swierstra, and Joly (2017) who propose RRI as a critique of TA. Interestingly, this struggle arises within Cluster 6 of our rri analysis. This is the social science cluster 6- Technology Development and Technology Assessment which contains both RRI and TA Technology Assessment though is adept at adapting. See the recent contribution of Grunwald (2020) who argues to re-cast TA away from its own historical origins rooted in consequentialist reasoning and towards a new form of TA, premised on excavating the societal meaning(s) attached to new technologies through a methodology which involves building recursive hermeneutic circles. TA as a well-established and well-resourced contender for a discourse coalition in its own right (it appears to meet Hajer's two conditions) and appears adept at reinventing itself from a solid base.
9. The locally-tailored responsible innovation component(s) of the training programmes of the EPSRC funded Centres of Doctoral Training in the UK are a case in point.

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No potential conflict of interest was reported by the author(s).

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References

- Agar, Jon. 2008. "What Happened in the Sixties?" *The British Journal for the History of Science* 41 (4): 567–600. doi:10.1017/S0007087408001179.
- Arnaldi, Simone, and Luca Bianchi. 2016. *Responsibility in Science and Technology: Elements of a Social Theory*. 1st ed. 2016 edition. Wiesbaden: Springer VS.
- Beck, Ulrich. 1992. *Risk Society: Towards a New Modernity*. Theory, Culture & Society. London ; Newbury Park, Calif: Sage Publications.
- Beecher, Henry K. 1966. "Ethics and Clinical Research." *New England Journal of Medicine* 274 (24): 1354–1360. doi:10.1056/NEJM196606162742405.
- Bensaude-Vincent, Bernadette. 2014. "The Politics of Buzzwords at the Interface of Technoscience, Market and Society: The Case of 'Public Engagement in Science'." *Public Understanding of Science* 23 (3): 238–253. doi:10.1177/0963662513515371.
- Bowker, Geoffrey C., Stefan Timmermans, Adele E. Clarke, and Ellen Balka, eds. 2015. *Boundary Objects and Beyond: Working with Leigh Star*. Infrastructures. Cambridge, MA: The MIT Press.
- Bridger, Sarah. 2015. *Scientists at War: The Ethics of Cold War Weapons Research*. Cambridge, MA: Harvard University Press.
- Burget, Mirjam, Emanuele Bardone, and Margus Pedaste. 2017. "Definitions and Conceptual Dimensions of Responsible Research and Innovation: A Literature Review." *Science and Engineering Ethics* 23 (1): 1–19. doi:10.1007/s11948-016-9782-1.
- Campbell, J. L. 2007. "Why Would Corporations Behave in Socially Responsible Ways? An Institution Theory of Corporate Social Responsibility." *Academy of Management Review* 32 (3): 946–967. doi:10.5465/AMR.2007.25275684.
- Carroll, Archie B. 1999. "Corporate Social Responsibility Evolution of a Definitional Construct." *Business & Society* 38 (3): 268–295. doi:10.1177/000765039903800303.
- Collingridge David. 1980. *The Social Control of Technology*. London, UK: Frances Pinter.
- Dacin, M. T., and P. A. Dacin. 2017. "Chapter 12. Traditions as Institutionalizes Practice: Implications for Deinstitutionalization." In *The SAGE Handbook of Organizational Institutionalism*, edited by Royston Greenwood, Christine Oliver, Kerstin Sahlin-Andersson, and Roy Suddaby. 2d edition. Los Angeles, London, New Delhi Singapore: SAGE Publications Ltd.
- Delvenne, Pierre. 2017. "Responsible Research and Innovation as a Travesty of Technology Assessment?" *Journal of Responsible Innovation* 4 (2): 278–288. doi:10.1080/23299460.2017.1328653.

- DiMaggio, Paul J., and Walter W. Powell. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields." *American Sociological Review* 48 (2): 147–160. doi:10.2307/2095101.
- Douglas, Mary, and Aaron Wildavsky. 1983. *Risk and Culture*. 1st edition. <https://www.ucpress.edu/book/9780520050631/risk-and-culture>.
- Felt, Ulrike. 2010. "Vers la Construction D'un Public Européen?" Translated by Anne Masseran and Robert Casel. *Questions de Communication* 17 (June): 33–58. doi:10.4000/questionsdecommunication.370.
- Fischer, Frank. 2003. *Reframing Public Policy*. Oxford University Press. <http://www.oxfordscholarship.com/view/10.1093/019924264X.001.0001/acprof-9780199242641>.
- Fischhoff, Baruch, Sarah Lichtenstein, Paul Slovic, Steven L. Derby, and Ralph Keeney. 1981. *Acceptable Risk*. Cambridge, UK: Cambridge University Press.
- Fisher, Erik. 2018. "Ends of Responsible Innovation." *Journal of Responsible Innovation* 5 (3): 253–256. doi:10.1080/23299460.2018.1513900.
- Fisher, Erik. 2020. "Reinventing Responsible Innovation." *Journal of Responsible Innovation* 7 (1): 1–5. doi:10.1080/23299460.2020.1712537.
- Flink, Tim, and David Kaldewey. 2018. "The New Production of Legitimacy: Sti Policy Discourses Beyond the Contract Metaphor." *Research Policy* 47 (1): 14–22. doi:10.1016/j.respol.2017.09.008.
- Funtowicz, Silvio O., and Jerome R. Ravetz. 1993. "The Emergence of Post-Normal Science." In *Science, Politics and Morality: Scientific Uncertainty and Decision Making*, edited by René Von Schomberg. Theory and Decision Library, 85–123. Dordrecht: Springer Netherlands. doi:10.1007/978-94-015-8143-1_6.
- Gibbons, Michael. 1999. "Science's New Social Contract with Society." *Nature* 402 (6761): C81–C84. doi:10.1038/35011576.
- Giddens, Anthony. 1990. *The Consequences of Modernity*. Stanford University Press.
- Glerup, Cecilie, and Maja Horst. 2014. "Mapping 'Social Responsibility' in Science." *Journal of Responsible Innovation* 1 (1): 31–50. doi:10.1080/23299460.2014.882077.
- Grunwald, Armin. 2020. "The Objects of Technology Assessment. Hermeneutic Extension of Consequentialist Reasoning." *Journal of Responsible Innovation* 7 (1): 96–112. doi:10.1080/23299460.2019.1647086.
- Guston, David H. 2004. "Responsible Innovation in the Commercialized University." *Buying in or Selling Out*, 161–174.
- Guston, David H., and Daniel Sarewitz. 2002. "Real-Time Technology Assessment." *Technology in Society*, American Perspectives on Science and Technology Policy, 24 (1): 93–109. doi:10.1016/S0160-791X(01)00047-1.
- Hajer, Maarten A. 1997. *The Politics of Environmental Discourse*. Oxford University Press. <https://www.oxfordscholarship.com/view/10.1093/019829333X.001.0001/acprof-9780198293330>.
- Hellström, Tomas. 2003. "Systemic Innovation and Risk: Technology Assessment and the Challenge of Responsible Innovation." *Technology in Society* 25 (3): 369–384. doi:10.1016/S0160-791X(03)00041-1.
- Jasanoff, Sheila. 2003. "Technologies of Humility: Citizen Participation in Governing Science." *Minerva* 41 (3): 223–244. doi:10.1023/A:1025557512320.
- Joly, Pierre-Benoit. 2019. "Reimagining Innovation." In *Innovation Beyond Technology: Science for Society and Interdisciplinary Approaches*, edited by Sébastien Lechevalier, 25–45. Creative Economy. Singapore: Springer. https://doi.org/10.1007/978-981-13-9053-1_2.
- Kitcher, Philip. 2001. *Science, Truth, and Democracy*. Oxford University Press.
- Lente, Harro van, Tsjalling Swierstra, and Pierre-Benoit Joly. 2017. "Responsible Innovation as a Critique of Technology Assessment." *Journal of Responsible Innovation* 4 (2): 254–261. doi:10.1080/23299460.2017.1326261.
- Ludwig, David, and Phil Macnaghten. 2020. "Traditional Ecological Knowledge in Innovation Governance: A Framework for Responsible and Just Innovation." *Journal of Responsible Innovation* 7 (1): 26–44. doi:10.1080/23299460.2019.1676686.

- Macq, Hadrien, Elise Tancoigne, and Bruno J. Strasser. 2020. "From Deliberation to Production. Public Participation in Science and Technology Policies of the European Commission (1998–2019)." *Minerva*. <https://link.springer.com/article/10.1007/s11024-020-09405-6>.
- Marshall, Fiona, and Jonathan Dolley. 2019. "Transformative Innovation in Peri-Urban Asia." *Research Policy*, New Frontiers in Science, Technology and Innovation Research from SPRU's 50th Anniversary Conference, 48 (4): 983–992. doi:10.1016/j.respol.2018.10.007.
- Merton, Robert K. 1935. *Sociological Aspects of Scientific Development in Seventeenth Century England*. Harvard: University of Harvard.
- Merton, Robert K. 1973. *The Sociology of Science: Theoretical and Empirical Investigations*. University of Chicago Press.
- Meyer, John W., and W. Richard Scott. 1983. *Organizational Environments: Ritual and Rationality*. Beverly Hills: Sage.
- Meyer, John W., and Brian Rowan. 1977. "Institutionalized Organizations: Formal Structure as Myth and Ceremony." *American Journal of Sociology* 83 (2): 340–363.
- Miller, Peter, and Nikolas Rose. 1990. "Governing Economic Life." *Economy and Society* 19 (1): 1–31. doi:10.1080/03085149000000001.
- Mody, Cyrus C. M., H. Otto Sibum, and Lissa L. Roberts. 2020. "Integrating Research Integrity into the History of Science." *History of Science* 58 (4): 369–385. doi:10.1177/0073275320952257.
- Moore, Kelly. 2013. *Disrupting Science: Social Movements, American Scientists, and the Politics of the Military, 1945-1975*. Princeton: Princeton University Press.
- Nentwich, Michael. 2017. "A Short Response to van Lente, Swierstra and Joly's Essay 'Responsible Innovation as a Critique of Technology Assessment'." *Journal of Responsible Innovation* 4 (2): 262–267. doi:10.1080/23299460.2017.1325698.
- Nordmann, Alfred, and Arie Rip. 2009. "Mind the Gap Revisited." *Nature Nanotechnology* 4 (5): 273–274. doi:10.1038/nnano.2009.26.
- Owen, Richard, and Nicola Goldberg. 2010. "Responsible Innovation: A Pilot Study with the U.K. Engineering and Physical Sciences Research Council." *Risk Analysis* 30 (11): 1699–1707. doi:10.1111/j.1539-6924.2010.01517.x.
- Owen, Richard, Phil Macnaghten, and Jack Stilgoe. 2012. "Responsible Research and Innovation: From Science in Society to Science for Society, with Society." *Science and Public Policy* 39 (6): 751–760. doi:10.1093/scipol/scs093.
- Owen, Richard, and Mario Pansera. 2019. "Chapter 3. Responsible Innovation: Process and Politics." In *International Handbook on Responsible Innovation: A Global Resource*, edited by Jonathan Hankins and René von Schomberg. Cheltenham, UK; Northampton, MA: Edward Elgar Publishing.
- Owen, Richard, Mario Pansera, Phil Macnaghten, and Sally Randles. 2021. "Organisational Institutionalisation of Responsible Innovation." *Research Policy* 50 (1): 104132. doi:10.1016/j.respol.2020.104132.
- Pestre, Dominique. 2009. "Understanding the Forms of Government in Today's Liberal and Democratic Societies: An Introduction." *Minerva* 47 (3): 243–260. doi:10.1007/s11024-009-9126-2.
- Polanyi, Michael. 1946. *The Planning of Science*. Oxford, UK: Potter Press.
- Polanyi, Michael. 1962. "The Republic of Science: Its Political and Economic Theory." *Minerva* 1 (1): 54–73. doi.org/10.1007/bf01101453.
- Randles, Sally. 2016. "Deepening Deep Institutionalisation: Elaborating a Concept and Developing a Typology to Analyse and Contrast the Institutionalisation of De Facto Responsible Research and Innovation (Rri) and H2020 RRI in Research and Technology Organisations." Deliverable 1.2 of the EU JERRI project. European Commission JERRI project (Joining Efforts for Responsible Research and Innovation). Project No 709747. https://www.jerri-project.eu/jerri-wAssets/docs/deliverables/wp-1/JERRI_Deliverable_D1_2_Deepening-Deep-Institutionalisation.pdf.
- Randles, Sally, B. Dorbeck-Jung, Ralf Lindner, and Arie Rip. 2014. "Report of the Roundtable at S.Net 2013: Where to Next for Responsible Innovation?" In *Innovation and Responsibility*,

- edited by C. Coenen, A. Dijkstra, C. Fautz, J. Guivant, C. Milburn, and Harro van Lente. Berlin: Akademische Verlagsgesellschaft AKA GmnH.
- Randles, Sally, Philippe Laredo, Allison Loconto, Bart Walhout, and Ralf Lindner. 2016. "Chapter 3. Framings and Frameworks : Six Grand Narratives of de-Facto Rri." In *Navigating Towards Shared Responsibility in Research and Innovation*, edited by Ralf Lindner, Stefan Kuhlmann, Sally Randles, Bjorn Bedstead, Guido Gorgoni, Erich Greisler, Allison Loconto, Bart Walhout, and Niels Mejlgaard, 31–38. Karlsruhe: Fraunhofer Institute for Systems and Innovation Research. <http://res-agera.eu/publications/res-agera-book-now-available/>.
- Rawls, John F. 1971. *A Theory of Justice*. Harvard University Press. <https://www.jstor.org/stable/j.ctvjf9z6v>.
- Reber, Bernard, and Sophie Pellé. 2013. "Innovation Responsable." In *Dictionnaire Critique et Interdisciplinaire de La Participation*, edited by I. Casillo, R. Barbier, L. Blondiaux, F. Chateauraynaud, J.-M. Fourniau, R. Lefebvre, C. Neveu, and D. Salles. Paris: GIS Démocratie et Participation. <http://www.dicopart.fr/it/dico/innovation-responsable>.
- Ribeiro, Barbara E., Robert D. J. Smith, and Kate Millar. 2017. "A Mobilising Concept? Unpacking Academic Representations of Responsible Research and Innovation." *Science and Engineering Ethics* 23 (1): 81–103. doi:10.1007/s11948-016-9761-6.
- Rip, Arie. 2010. "De Facto Governance of Nanotechnologies." In *Dimensions of Technology Regulation*, edited by M. Goodwin, B.-J. Koops, and R. Leenes, 285–308. Nijmegen.
- Rip, Arie. 2016. "The Clothes of the Emperor. An Essay on RRI in and Around Brussels." *Journal of Responsible Innovation* 3 (3): 290–304. doi:10.1080/23299460.2016.1255701.
- Rip, Arie. 2018. "Chapter 4. De Facto Governance of Nanotechnologies." In *Futures of Science and Technology in Society*, edited by Arie Rip, 75–96. Technikzukünfte, Wissenschaft Und Gesellschaft / Futures of Technology, Science and Society. Wiesbaden: Springer Fachmedien. doi:10.1007/978-3-658-21754-9_5.
- Robinson, Douglas K. R., Angela Simone, and Marzia Mazzonetto. 2021. "RRI Legacies: Co-Creation for Responsible, Equitable and Fair Innovation in Horizon Europe." *Journal of Responsible Innovation* 8 (2): 209–216. doi:10.1080/23299460.2020.1842633.
- Saille, Stevienna de. 2013. "Innovating Innovation: Rri as a Guiding Principle in the ERA." *SSRN Electronic Journal*, doi:10.2139/ssrn.2401076.
- Scher, Stephen, and Kasia Kozłowska. 2018. "The Rise of Bioethics: A Historical Overview." In *Rethinking Health Care Ethics*, edited by Stephen Scher and Kasia Kozłowska, 31–44. Singapore: Springer. https://doi.org/10.1007/978-981-13-0830-7_3.
- Schmidt, Vivien A. 2008. "Discursive Institutionalism: The Explanatory Power of Ideas and Discourse." *Annual Review of Political Science* 11 (1): 303–326. doi:10.1146/annurev.polisci.11.060606.135342.
- Schmidt, Vivien A. 2010. "Taking Ideas and Discourse Seriously: Explaining Change Through Discursive Institutionalism as the Fourth 'New Institutionalism.'" *European Political Science Review* 2 (01): 1–25. doi:10.1017/S175577390999021X.
- Schmidt, Vivien A, and Claudio M Radaelli. 2004. "Policy Change and Discourse in Europe: Conceptual and Methodological Issues." *West European Politics* 27 (2): 183–210. doi:10.1080/0140238042000214874.
- Schomberg, René von. 2011. "Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields." In *Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields*, edited by René von Schomberg, 7–16. Luxembourg: Publications Office of the European Union.
- Schomberg, René von. 2012. "The Quest for the 'Right' Impacts of Science and Technology. An Outlook Towards a Framework for Responsible Research and Innovation." In *Les Nanotechnologies: Vers Un Changement D'échelle Éthique?*, edited by Céline Kermisch, and Marie-Geneviève Pinsart, 269–287. Université Libre de Bruxelles: EME. http://www.researchgate.net/publication/255696876_thiques_en_action_Collection_dirige_par_Celine_Kermisch_Posthumanisme_Mylene_botbol_baum/file/60b7d520354c6380f1.pdf.

- Schomberg, René von. 2013. "A Vision of Responsible Research and Innovation." In *Responsible Innovation*, edited by Richard Owen, John Bessant, and Maggy Heintz, 51–74. Chichester, UK: John Wiley & Sons.
- Schot, Johan, and Arie Rip. 1997. "The Past and Future of Constructive Technology Assessment." *Technological Forecasting and Social Change*, Technology Assessment: The End of OTA, 54 (2-3): 251–268. doi:10.1016/S0040-1625(96)00180-1.
- Shanley, Danielle. 2021. "Imagining the Future Through Revisiting the Past: The Value of History in Thinking About R(R)I's Possible Future(s)." *Journal of Responsible Innovation* 8 (2): 234–253. doi:10.1080/23299460.2021.1882748.
- Star, Susan Leigh, and J. R. Griesemer. 1989. "Institutional Ecology, Translations and Boundary Objects - Amateurs and Professionals in Berkeley's-Museum-of-Vertebrate-Zoology, 1907-39." *Social Studies of Science* 19 (3): 387–420.
- Stark, Laura. 2011. *Behind Closed Doors*. Morality and Society Series. The University of Chicago Press. <https://press.uchicago.edu/ucp/books/book/chicago/B/bo12182576.html>.
- Starr, C. 1969. "Social Benefit Versus Technological Risk." *Science* 165 (3899): 1232–1238. doi:10.1126/science.165.3899.1232.
- Stilgoe, Jack, Richard Owen, and Phil Macnaghten. 2013. "Developing a Framework for Responsible Innovation." *Research Policy* 42 (9): 1568–1580. doi:10.1016/j.respol.2013.05.008.
- Stirling, Andy. 2019. "How Deep Is Incumbency? A 'Configuring Fields' Approach to Redistributing and Reorienting Power in Socio-Material Change." *Energy Research & Social Science* 58 (December): 101239. doi:10.1016/j.erss.2019.101239.
- Sutcliffe, Hilary. 2011. *A Report on Responsible Research and Innovation*. MATTER.
- The Belmont Report. Ethical Principles and Guidelines for the Protection of Human Subjects of Research. 1979. The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research.
- Vincent, Nicole A. 2011. "A Structured Taxonomy of Responsibility Concepts." In *Moral Responsibility*, edited by Nicole A. Vincent, I. van de Poel, and Jeroen van den Hoven, 15–35. Springer. <https://papers.ssrn.com/abstract=1662385>.
- Wiarda, Martijn, Geerten van de Kaa, Emad Yaghmaei, and Neelke Doorn. 2021. "A comprehensive appraisal of responsible research and innovation: From roots to leaves." *Technological Forecasting and Social Change* 172: 121053.
- Zucker, Lynne G. 1983. "Organizations as Institutions." In *Research in the Sociology of Organizations*, edited by Sam Bacharach, 1–47. Greenwich, CN: JAI Press.