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Critiques from within. A modest proposal for reclaiming critique for responsible innovation

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ABSTRACT

How can critique in responsible innovation (RI) become generative? The anything-but-neutral relations between science, technology and society, at the core of science and technology studies, have led to the development of different repertoires of critique. None of them fitted the configurations in the biomedical practices we came to study. There, biomedical experts presented us with an analysis of the power relations perpetuated through the mainstream practices in their fields and had built socio-material alternatives to the common forms of practicing biomedicine. The paper suggests conceptualising critical observations voiced by experts embedded into socio-material alternatives as ‘critique from within’ yielding collateral goods and bads. Rather than asking how to foster responsibility conditions in RI, the paper suggests modestly reclaiming critique by articulating already existing forms of responsibility practices developed by experts themselves and analysing the ambivalent effects they engender.

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Introduction

The critical potential of research and innovation that advertises itself as ‘responsible’ has come under scrutiny recently.¹ Some scholars (e.g. Owen, Macnaghten, and Stilgoe 2012; Schomberg, René, and Hankins 2019) have argued that Responsible (Research and) Innovation activities, such as R(R)I national programs, citizen science panels, technology assessments, co-design projects, or mid-stream modulation, are fundamentally ‘critical’ (Schomberg, René, and Hankins 2019, 6). R(R)I initiatives amount to nothing more than the pragmatic and institutionalised translation of critiques that social and humanistic scholarship – especially in the field of science and technology studies (STS) – has addressed at technoscientific innovation. This view highlights the role of R(R)I

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schemes in challenging the dominant global economic paradigm (Schomberg, René, and Hankins 2019, 6), because they assess not only the value of innovations but also the values that are embedded *in* innovations. By including citizens and civil society in innovation, R(R)I programmes offer more inclusive ways of developing science and technology. Technoscience guided by R(R)I is geared towards inclusive societal changes, and expected to bring about the futures desired by citizens: it is science *for and with* society (Owen, Macnaghten, and Stilgoe 2012; Owen, von Schomberg, and Macnaghten 2021). Other scholars (Blok and Lemmens 2015; Felt 2017; 2018) have cautioned against a simplistic view of the relationship between critical scholarship in the social sciences and humanities and R(R)I activities. They have defended what could be called a conflictual view of such a relationship. More than just a practical implementation and policy uptake of critique (in all its forms), R(R)I would produce, under this interpretation, minimal change, serve neoliberal ideas and reproduce dominant structural global inequalities. R(R)I is, in this vein, ‘an empty signifier, old wine in new bottles’, or just ‘an incoherent, passing policy fad’ (Owen, von Schomberg, and Macnaghten 2021, 224). Citizen engagements, according to this view, are often skewed towards convincing participants to support technoscientific innovation, rather than opening up debates around agenda setting, social priorities and structural change. R(R)I activities would, in this line, depoliticise debate rather than foster deliberation (Felt 2017). In laboratories, R(R)I activities may end up becoming ritual performances carried out at the beginning and the end of projects, which reinforce micro-politics and tacit epistemic hierarchies (Felt 2017). In the neoliberal climate of academia, R(R)I activities nudge the actors of research and innovation (e.g. researchers, practitioners, innovators, policymakers) into opting for a division of moral labour whereby reflexivity and social responsibility are outsourced to social scientists or simply imported as ready-made solutions. These different positions raise several intersecting questions: Is the potential of critique through R(R)I activities exhausted by these two alternative readings? Might there be, perhaps, more forms of critique available to R(R)I? And, most importantly: How can critique be fostered, reclaimed, substantiated, or multiplied for the purpose of R(R)I?

As R(R)I is building upon the intellectual underpinnings, institutional anchoring, interdisciplinary collaborations and stakeholders offered by STS, these questions tie into larger debates on critique of science and technology in socio-democratic, technology- and innovation-driven societies at the beginning of the twenty-first century. R(R)I is, as Danielle Shanley puts it in her insightful history of R(R)I, ‘inextricably bound up with the history of STS’ (Shanley 2022, 58). R(R)I has built upon STS in various ways over the years. STS scholarship has been a source of ‘decades of discussions and debates [...] concerning the complex evolution, social dimensions, and potential impacts of technologies’ (Shanley 2022, 54). This has offered a critical voice reclaiming the importance of ‘interdisciplinary collaborations both inside and outside of the academy’ to R(R)I and its predecessors (e.g. anticipatory governance, ELSI/ELSA, or technology assessment). Yet, Shanley reminds us that a linear, triumphalist view of the relationship between STS and (different incarnations of) R(R)I should be strongly avoided: there are plenty of instances where STS critique failed to matter in exercises of responsibility within scientific and technological

innovations. R(R)I and STS should therefore be seen as open (social) fields, variously stable and porous with respect to one another.

Since its inception, STS scholarship has been concerned with the anything-but-neutral mutual relations and influences between science, technology, and society. In their engagements with these interactions, over the years, STS scholars have not only developed different repertoires of critique: they have questioned whether ‘critique has run out of steam’ (Latour 2004), or have pursued distinct ambitions for a proactive commitment towards baking socially desirable values into technoscience. By interrogating critique in STS, this paper aims to interrogate the continually developing project of bringing critical approaches in STS closer to institutional languages such as R(R)I. Far from providing a definitive answer that is fixed in time, our goal is to contribute to the existing literature that treats this relation as continually evolving. Thus, we interrogate the underpinnings of responsibility – as missing bit singled out by critique, as pragmatic engagement, as governance structure, etc. – for the sake of generating ‘new manifestations of responsibility’ in science and technology as practices taking specific shapes at the beginning of the twenty-first century (Randles et al. 2016, 33).

While we do not expect our take on STS critique of and for R(R)I to permanently capture this relation, the paper proposes an empirical attention to and the analytical uptake of a thus-far understudied form of critique. We call this: *critique from within*. We define critique from within as a critique of science and technology that originates in practitioners’ daily life beliefs, practices and technoscientific activities. Practitioners may be aware of the biases and errors that are built into mainstream practices and common uses of technologies in their fields. In the face of such recognition, they may build concrete, socio-material, local alternatives to the mainstream practices, thus, enacting a critique of them – in practice. We exemplify this through our case studies of biomedical practices, which have been primes sites of research and innovation over decades if not centuries. Yet, we hold no strong reason to believe that other empirical cases may not spur additional insight into the forms and features of (what we call) critique from within.

In the following, we first map the landscape of critique of biomedicine in STS and lay out in detail the most important repertoires of critique that have been developed in the field (section 2). Then, we describe the data upon which our argument is based: two ethnographic projects investigating distinct biomedical practices in Central Europe (section 3). Through the example of Marie Dupont, an epigeneticist who leads a lab that developed an experimental protocol on environmental enrichment, section 4 empirically exemplifies critique from within. A brief intermezzo follows, which analyses and singles out the defining features of critique from within. Section 5 introduces the case of Eva Doblinger, a nephrologist who in her dialysis unit initiated a palliative renal replacement therapy programme. In the second intermezzo, we analyse the consequences of critique from within: it gives rise to local and specific effects on the configurations of research and healthcare it is part of. Combining John Law’s notion of ‘collateral realities’ (2009) with Annemarie Mols’ idea of ‘goods’ and ‘bads’ (2002), we call these effects ‘collateral goods and bads’. In the conclusion, we spell out how critique from within can be used in researching, engaging in, and setting up R(R)I activities. Crucially, critique from within suggests that critique is not a prerogative of the social sciences. Instead, we propose to draw in a more modest way on the creativity, reflexivity and craft of

biomedical practitioners themselves to open up a new repertoire of critique for R(R)I programmes. By detailing how critique from within arises and can be used, our paper provides an empirically-informed suggestion as to how to reclaim and expand critique in RI.

Critique in science and technology studies

A variety of, what we want to call, repertoires of critique exist in STS research on biomedical practices. They differ fundamentally in terms of the *style* in which the anything but neutral relations between science, technology and biomedicine are analysed (Mol 2006b). These different styles result from choosing specific objects of research, settling on certain methods, collecting particular data, establishing in this process special relations with informants, as well as producing distinct results and singular arguments (Law 2004). In what follows we lay out the four most common repertoires of critique of biomedical practices in STS. While in doing so we distinguish styles, we wish to underline that the repertoires do not necessarily constitute distinct theoretical strands in STS. In fact, one analytical strand can employ several repertoires of critique at once. Rather than an exhaustive coverage of the analytical sensitivities in STS, we thus see these critical repertoires as an open ended list to which other repertoires could be added (if, for example, one set out and studied, to give just two examples, public engagements with biomedical practices or patients' daily living with medical innovations).

A first thread of critique in STS consists in showing *the socially constructed nature of scientific knowledge*. Its target are notions ranging from 'truth' to 'facts' and 'knowledge', and its origins in STS are multiple. It has, for instance, a historiographic and epistemological foundation in the work that, through Thomas Kuhn (and the rediscovery of Ludwig Fleck) promotes a fundamentally anti-realist philosophy of science. Facts are socially constructed in the sense of being the result of a priori structures, materialities and organisations of research, as well as social collectives of practice, which are historically and socially situated. The strength of this post-Kuhnian critique is to unveil historical and epistemological transformations in the ways of knowing: these act as gestalt switches between incommensurable paradigms of knowledge production. In their early work, Bruno Latour and Steve Woolgar offer a similar thesis grounded on a laboratory ethnography presented in their seminal *Laboratory Life* (Latour and Woolgar 1986). Their work offers also an anti-realist ontology of scientific knowledge anchored in the material grounding of the laboratory's sociotechnical system. 'Truth' is an emergent property of an actor-network (instead of a historicised a priori structure): a heterogeneous, social, material, semiotic assemblage which is an obligatory passage point to produce facts. The methodology that the STS scholar employs here consists less of historical and epistemological analysis, and more of unpacking through ethnographic fieldwork the interdependence between the composition/working of sociotechnical networks and the knowledge they produce. Critique, in this repertoire, takes the form of de-universalising the value of truth: an analytical move which is not devoid of controversy.²

A second major form of critique in STS takes off from a concern for *power dynamics in the relations between science, technology, and society*. Descending from a Foucauldian tradition, this critique brings into view how scientific practice is a 'rationalized attempt to intervene upon' the function, characteristics and relations of human existence (Rabinow

and Rose 2006). Studies of *biopower* are exemplary of this form of critique. Biopower designates here those processes where the interplay of power and knowledge addresses the vital and bodily characteristics of human beings. The arguments that the STS scholars offer, often based on an analysis of discourses, deconstruct the truth and values science, technology and medicine bring into different social and political processes. These arguments can take the form of a study of the effects on the human condition produced by notions such as risks, susceptibility or disease; or, they can aim at demonstrating how science, technology and the medical domain legitimise certain authorities to speak about and intervene into the functioning of human bodies, life and death. Finally, biopower critiques also scrutinise how scientific knowledge configures novel relations, identities and collectives, ‘biosocialities’. In the cognate but distinct tradition of technology studies (e.g. Akrich 1992; Winner 1980), the STS analyst dismantles how the use of supposedly ‘neutral’ technologies not only enables certain interests to be pursued (to the detriment of others), but also distributes responsibilities in uneven ways. This kind of critique, thus, unmaskes the systematic biases and power imbalances built into the fabric of truth claims, technologies, and medical concerns with life and death that can lead to major human suffering. Critiquing, here, is done by politicising science and technology.

A third repertoire takes the form of *generative critique*. Inspired by the early work of Helen Verran (2001) this repertoire has been developed by scholars such as Sonja Jerak-Zuiderent (2015), Jörg Niewöhner (2016), Des Fritszgerald and Felicity Callard (2015), Line Hillersdal and colleagues (2020), or Mareike Smolka and colleagues (2020a; 2020b). The approach of generative critique arose in opposition to the first two repertoires of critique encountered above. Ebullient and deconstructive engagements with scientists and innovators, proponents of this repertoire argue, may miss out on the opportunity to redress social concerns in the light of scientific evidence. A more productive and credible approach consists instead in setting up an interdisciplinary collaboration³ between (for instance) natural and social scientists (including sometimes also scholars from the humanities) around issues such as global warming (Niewöhner 2016) or performance indicators in healthcare (Jerak-Zuiderent 2015). When engaging with natural scientists, during meetings, the setting up of experiments, or the discussion of data, particular attention is paid by the social scientist to moments in which collective bewilderment, doubt, excitement, resignation (Hillersdal et al. 2020), or laughter (Jerak-Zuiderent 2015) arise, which manifest themselves in bodily disconcertment (Verran 2001) felt by the social scientist. These moments are interpreted not only as instantiations of disciplinary differences. They are taken to be events in which the dominant way of framing and solving a problem becomes unsettled and routine practices, economic and political agendas, as well as established expertise and evidence hierarchies are questioned. These moments become subsequently the starting point for natural and social scientists to reconfigure a problem: different knowledge can be produced about it, and different solutions offered collectively. Critique means here opening up a dominant way of framing and solving an issue, as well as complementing it by other ways of ‘seeing and doing’ that wish to find new ways of ‘living together in difference’ (Verran 2001). In this repertoire, critique signifies re-inventing a problem in scientific and other kinds of practices.

A yet again different form of critique, the *articulation of alternatives*, has been pursued by Annemarie Mol (2008), Jeannette Pols (2004), Rita Struhkamp (2005), Vickey Singleton (2010) or Ingunn Moser (2010). It proceeds by identifying what through Enlightenment and Modernity, in liberal social theories or public and media discourses is othered. These are, amongst others, bodies, their pleasure and pain (Mol, Moser, and Pols 2010, 7), the fleshiness and fragility of life (Mol 2008, 11). In a second step, the researcher identifies situations and sites in which what is neglected and forgotten becomes attended to. In the case of bodies, their pleasures and pain are cared for in rehabilitation centres, psychiatric wards, or outpatient clinics. There, the STS scholar observes as a temporarily visiting scholar what is happening. She then carefully puts into words the witnessed practices and their inherent logics, which are verbally unavailable to practitioners. Particular attention is paid to avoiding importing terms that have been coined for other purposes and to the limits of what can be put into words at all, while sometimes words are used deliberately to then shift their meaning (Mol 2006a; Moser 2010). In this form, critique articulates other ways of living with bodies, their pleasures and pain, for instance by providing 'good care' (Pols 2004) and 'enacting appreciation' (Pols 2005), rather than offering 'choice', 'autonomy' or 'control' which are the ideals celebrated in liberal social theories, and public and media discourses. Instead of unpacking truth claims made *about* bodies (as it is done in the first repertoire of critique), scholars in the fourth repertoire seek to interfere with daily practices of living *with* bodies and contribute to generating better ways of doing so. The scholar, in this case, makes visible what becomes usually othered, articulates heterotopias (Foucault 1986) that exist but are neither visible nor attended to in the West. Critiquing, in this strand, is done by articulating the othered.

This variety of forms of critique of biomedical practices shows that the anything-but-neutral effects of the multiple relations between science, technology and society have received extensive scrutiny in STS. And examples abound on the ways these repertoires of critique have been mobilised in situated R(R)I initiatives. Constructivist critique has shown how science policy has to be argued into place, and how these argumentative processes are crucial to unpack for RI (Popa, Blok, and Wesselink 2020). Power-sensitive critique in STS has been foundational in marking the distinction between existing ELSA/ELSI approaches to the implications of technoscience and the centrality in R(R)I of entangling critique in emerging science and technology (Stilgoe and Guston 2017). The practice of generative critique is central to current interdisciplinary R(R)I collaborations (Smolka 2020a). And the emphasis on attending to alternatives has been highlighted as holding major methodological implications for R(R)I and its capacities of grasping valuing processes in the making (Boenink and Kudina 2020).

But what happens when none of these repertoires applies to an empirically observed configuration of science, technology and the medical domain? It is, we will show, not only an occasion to expand the list of repertoires of critique developed in STS, but also an opportunity to modestly reclaim critique in R(R)I practices.

Materials and methods

Our paper is based on two research projects on biomedical practices in Central Europe at the beginning of the twenty-first century. Both projects had a traditional set-up in the

sense that the STS scholar entered the field, observed biomedical practices in specific sites, regularly visited these places, interacted with the experts, and, after leaving the field, analysed findings for an STS and social science audience.

The first project (by Luca) studied research practices of epigenetics; that is, the study of functional modifications of DNA due to environmental factors, material exposures and life experiences, which have consequences for health risks and phenotypic development. The focus of Luca's research was on the sociotechnical configurations of the epigenetics lab (e.g. protocols, experimental systems, evidence, knowledge claims, etc.) that partake in the reproduction of moral economies (Fassin 2012) of individual and collective responsibilities for health in our societies. Data was collected between 2016 and 2018 in Switzerland by zooming in on epigenetic research and knowledge on parental and intergenerational responsibilities for the protection of future generations' health.⁴ The specific questions on which we expand here relate to the practices of one of the labs studied in this project, which is located at (what could be called) the 'University of Switzerland' (UoS). The materials we employ draw from a set of interviews ($n = 22$), and an additional round of data collection tailored to the specific practices of this laboratory including: (i) in-depth analysis of the lab's publications and of the literature on their techniques; (ii) several week visits for both informal and formal observations of laboratory procedures, experiments and meetings; (iii) exchanges with lab members and the principal investigator (PI); (iv) one final in-depth interview with the PI exploring themes emerging from previous interviews, observations and analyses of the lab's work.⁵

The second project (by Anna) investigated medical practices through the example of one medical speciality, nephrology which deals with kidneys and their diseases. The project focused on the enactment and care of a value, namely quality of life, in the clinical practices of nephrology (Dussauge, Helgesson, and Lee 2015; Mol, Moser, and Pols 2010). It analysed how, in this process, particular politics of living and dying with chronic diseases unfold at the beginning of the twenty-first century (Wahlberg and Rose 2015). Data was collected between 2016 and 2018 in Austria in two hospitals, in which the internal medicine section included a nephrology department.⁶ They will be called here the *City Hospital* and the *Mountain Hospital*. Daily, mundane practices of providing health care to patients with chronic kidney disease in the two units were recorded through participant observation for 32 days. As nephrologists had set up in both places projects to, as they stated, 'improve their patients' quality of life', semi-structured, formal and informal interviews with the persons involved in the projects were carried out: physicians ($n = 5$), nurses ($n = 5$), and a psychologist ($n = 1$). With two physicians respectively two follow-up interviews were conducted. In addition, documents that had been produced during the development of the projects were collected and analysed. Materials on these clinical nephrology practices was contextualised through participant observation at national and international nephrology and nephrology nursing conferences ($n = 3$) and interviews with key stake holders in Austrian nephrology ($n = 5$).⁷

While there exist several differences between epigenetics and nephrology, between 'the lab' and 'the clinic' (Mol 2002), comparing notes of observations offered us the realisation of striking similarities across these two settings. We had observed how, both in epigenetic research in Switzerland and nephrology practice in Austria, most professionals were concerned with getting along in their day-to-day work. They practiced the dominant,

mainstream approaches to scientific knowledge production and performed the archetypal kind of modern biomedicine. Yet, some professionals offered us a different creative craft, which was made up of critical reflections about mainstream practices in their field. Of note, these outlooks on their practices were neither formulated in the precise jargon of social scientists, nor were they just a discursive, if not rhetorical, acknowledgement of the pertinence of critique. Rather, they were a reality to enact on a daily basis: they fuelled into practices meant to ‘improve’ research and clinical practice in the face of critique. In the remaining, we present two exceptionally outspoken and active biomedical experts and the projects that they came to set up in their work.

Marie Dupont’s lab and their protocol for environmental enrichment

Marie Dupont is a renowned epigenetic scientist who identifies as neuroepigeneticist, due to her doctoral studies under the supervision of a Nobel laureate neuroscientist and her extensive track record in research on the epigenetics of stress. When Luca first met her for an interview in 2016, she coordinated since more than a decade an epigenetics laboratory at the UoS (henceforth the UoS lab) working on the transgenerational epigenetic inheritance of ‘early-life stress’⁸ in a mouse model. Known as ‘behavioural epigenetics’, this field of research investigates the long-term, potentially even multigenerational, effects on behavioural phenotypes, neural functioning and gene expression of adverse early-life experiences and the social environment.

In the UoS, ‘early-life stress’ consisted of a protocol for repeated and aleatory three-hours-per-day separation of the mouse dam (F0 generation) from its pups (F1 generation) during the weaning period (the first twenty-one days of a mouse’s life). Added to this separation events were also stress conditioning protocols to which the dam was subjected during the same timeframe. The induced maternal stress produced behavioural alterations in the parenting of the dam (e.g. nursing, licking and grooming), which – as Marie Dupont, her team and others observed – resulted in turn in behavioural patterns and molecular/metabolic (epigenetic) alterations in the pups. These predispositions could also be passed across several generations through the germline. Scientists at UoS, like others elsewhere, postulated that gene-environment interactions resulted in particular patterns of behaviour, cognitive skills, personality traits and mental health (Sandi and Haller 2015). In addition, the research at UoS was a prominent example of studies postulating a transgenerational transmission of epigenetic modifications (Bohacek and Mansuy 2015). Epigenetics in the context at issue was the study of molecular events that govern the ways nurture (i.e. early-life experiences and the social environment) shapes nature (i.e. the functioning of an organism’s genome) in ways that affect health and behaviour across multiple generations.

This emphasis on molecular differences as explanans of stress-related disorders became a socio-politically relevant observation when translated into strategies of intervention into the epigenome. While following members of the UoS lab, Luca came to learn that the most widely used approaches to the reversal of these differences (and the disease predispositions they are taken to signify) consisted of the use of specific classes of drugs known to act on the epigenetic machinery, such as DNA methyltransferases (DNMTs) and histone deacetylases (HDACs) inhibitors (Day 2014; Szyf 2009). And, in fact, both Marie’s lab and others had successfully targeted the epigenetic machinery of

stress- and trauma-related disorders with so-called epi-drugs and epi-nutriceuticals (Naidoo, Martínez-Iglesias, and Cacabelos 2022). An informant giving a talk at a conference hosted by Marie's group in 2017 summarised this dominant form of imagination and practice of intervention in the following way. The typical solution to the mixed social and biological patterning of stress-related conditions offered by epigenetics has two main features, he argued. First, scientists disentangle the precise mechanistic pathways, and therefore the heterogeneity, of disease aetiology of psychiatric disorders. Each traumatic experience may have its own epigenetic signature. Second, and most importantly to this expert, these molecular traces of (adverse) experiences can be the target of pharmacological interventions: when traumatised, he rhetorically concluded his talk, 'you can come to me and I'll give you a drug' (Fieldwork notes, August 2017).

The interview guide with which Luca had entered the UoS had been thoroughly imbued with STS literature on biomedical research that had emphasised how the normative and the epistemic mutually shaped each other to become an influential source of biopower (e.g. Rabinow and Rose 2006). The interview guide had, in other words, been influenced by the second repertoire of critique we encountered in the previous section. But, as Luca's conversation with lab members went on, Luca became increasingly aware that their practice could not be fully grasped as a source of biopower that others had previously described. The UoS lab did not expect molecular, individual-based interventions to be the only significant strategy of intervention into the bio-social patterning of stress-related disorders. During a hot summer afternoon visit, Marie had given Luca one hour of her time to discuss about epigenetics and how these experimental practices feed into discourses of biomedical intervention into complex bio-social phenomena such as stress, or individual responsibilities to protect our epigenome for the sake of future generations. As the conversation was coming to an end, Marie elaborated on the need to stretch her science of the molecular marks of adverse social experiences beyond molecular and individual-based repertoires of intervention. While these study designs were easier to publish, she argued, it remained unclear how much they could lend legitimacy to the, in her view, much-needed social interventions into the structural causes of these stressful experiences. Cutting off Luca's wrap-up of the conversation, she elaborated:

MARIE: In an ideal world, epigenetics should make us more aware of the consequences of our acts, what we do, or we are brought to do, and especially of the environment. [...] But we often prioritize other interests as scientists. We are far from the ideal world in which we will put all of this to work as it should ...

LUCA: A very positive note to end our interview ... [I laugh]

MARIE: [She laughs] ... True, let me tell you about the potential of reversibility. We did a proof-of-principle study [in our model] showing that an enriched environment – more toys, more activities, more food – for the father could remedy to its trauma and prevent the transmission in the progeny. A phenotype that was reversed in a couple of weeks, from weaning to adulthood! (Interview 1)

In the quote, Marie clearly hinted at her dissatisfaction with mainstream strategies of intervention into the epigenetic marks of 'early-life stress'. She questioned them by pointing to the 'interests' of scientists that, as she elaborated in the conversation, often lean towards the search for pharmacological remedies more than the acknowledgement of the structural and social origins of these effects. She voiced what STS scholars have

pointed out in numerous ways: if this version of epigenetics takes issue with the entanglement of ‘the social’ and ‘the biological’, how come that the ‘varied, contingent and multi-factorial’ nature of this entanglement gets lost in scientists’ operationalisations of these phenomena (Chung et al. 2016, 180)? How is it that epigenetic knowledge of ‘how life events and environmental exposures are literally embodied’ fails to highlight the specific ‘historical, social, political, and environmental realities’ producing these effects and offers only a molecular representation of these phenomena (Lock 2013, 292)? Much like STS scholars, but on different grounds, Marie warned that molecular endpoints of experiences could be treated with different strategies of intervention, thus positioning them differently in the public translation of epigenetic knowledge. And this, because epigenetics is supposed to precisely underline the contribution of (material, social) environments to human health and illness (Landecker and Panofsky 2013). In other words, Marie had crafted something resembling to a biopower-based critique of her practice that, while without its name, still pointed to the biases built into mainstream epigenetics and their socio-political reverberations.

Not only, however, did Marie argue that mainstream epigenetics science was problematic. In the second part of the quote, she brought up that her team had set up a different arrangement of equipment, technologies, material environments, human and non-human animals to depart from these mainstream approaches. They had done a ‘proof-of-principle study’ to probe the importance of contextualising epigenetic findings and uncover avenues for health intervention beyond molecular and pharmacological treatment of these effects. They had done so by developing a protocol for so-called environmental enrichment.

Protocols for Environmental Enrichment (EE) in animal experimentation have a long-standing history in neurosciences (Hannan 2014; Nelson 2016). In the UoS lab, EE consisted concretely of an intervention into the housing conditions of laboratory animals, which was directed at offering them a more stimulating environment than the standard caging. EE was practiced through a two-floored cage, far bigger than the standard one, which was composed of different modules providing sensory, cognitive and physical stimulation to the mice. Besides a compartment with running wheels for physical exercise, the cage was made of a maze (for cognitive stimulation) and a compartment with food. Also, the cage could host up to six mice, allowing the animals to enjoy interactions and to associate in group behaviours that were impossible in the standard cages of the laboratory. Most importantly, the EE cage enabled UoS scientists to modulate the ‘aberrant’ epigenetic marks of early-life experiences and prevent their transmission across generations in a very different way. They published only (what they called) a proof-of-principle study: namely, an article which was the first of this kind in behavioural epigenetics reporting on preliminary evidence of the efficacy of this environmental intervention in reversing the epigenetic marks of early-life stress. Administering this intervention in the controlled environment of the lab could not only reverse these epigenetic modifications, but also their behavioural correlates, and prevent transmission of these modifications across generations.

The UoS lab, thus, developed EE as a therapeutic alternative to the popular option of pharmacological treatments of stress-related conditions in epigenetics. Marie and colleagues used this technique to demonstrate a different way to tinker with the reversibility and malleability of the epigenome: one that emphasised interventions in the material and social environment for the prevention of the long-term effects of stressful experiences. In

Marie's voice, EE was a reminder that the problem of early-life stress and its consequences for health lay in 'the social interactions' and 'living conditions' of our societies: 'EE means thinking systemically about portions of our society that are regularly frustrated because of jobs, educational system, lack of opportunities' (Interview 2). In the idiom of this paper, instead, EE exemplifies how the actors can inject critique within the mangle of their practice.

Intermezzo: critiquing mainstream practices from within

The biomedical experts whom we encountered during our fieldwork did not engage in a collaboration with us, the social scientists. We did not, in line with the third repertoire of critique in STS, experience disconcerting moments, destabilise dominant enactments of problems, and elaborate other solutions, or ways of seeing and re-doing these issues. Nor were all the practices going on in the epigenetics laboratory (and the dialysis unit, as we shall see) substantively different from dominant patterns of practice. This took away from the toolbox of the social scientist the possibility to put alternative practices and their logics into words and lead the way into an articulation of heterotopias, like done in the fourth STS repertoire of critique. We did, according to the first repertoire of critique, highlight the constructivist features of the epistemic and normative dimensions of epigenetics and nephrology. However, we were not the only ones concerned with the mediated characters of biomedical entities and their socio-political reverberations (per the second repertoire of critique). Instead, in the epigenetics laboratory at the UoS and Marie Dupont's encounter with Luca – much like (as we will see) in the dialysis unit of the City Hospital and Eva Doblinger's exchanges with Anna – different forms of critique had already crystallised within a set of practice. They had been initiated and voiced by leading practitioners in these settings, and involved an extended network of colleagues, tools, patients, humans and non-human animals. This critique did not have the guise of social sciences scholarship, nor did it require social scientists to put it into words, nor was it generated in a collaborative setting: the mainstream ways of doing were already unsettled before our arrival, the routine practices questioned and diverted, and the economic and political agendas of the fields built into these practices already tweaked to match the demands of critique.

Marie Dupont and Eva Doblinger (whom you will encounter below) exemplify that there are experts who are not only reflexive practitioners (Schön 1984); namely, experts who think about what they are doing while doing it, for instance, during methodological discussions on the limitations of a study (in a laboratory) or in ethics round table meetings (in a hospital).⁹ Marie Dupont and Eva Doblinger are experts who recognise the systematic biases, errors, and suffering created and perpetuated through the mainstream practices of their fields – like the second repertoire of critique in STS does. They voice these observations when interviewed by a social scientist. To be clear, this is not tantamount to say that they are radical scientists or marginal practitioners against the tide. These actors set a distance between themselves and the problematic aspects of their field, while being fully integrated in their respective biomedical fields. They rather testify of a capacity to maintain a conflictual and opportunistic way of doing mainstream biomedicine: one can be well-established in a field while using such a position to demarcate oneself from colleagues. Crucially, these biomedical experts

present an emic analysis of the perpetuation of power relations through their practices. This is the reason why we call it ‘critique *from within*’:¹⁰ as the critique, in this case, is voiced by the expert. It emerges from within biomedical practices rather than being brought to the practices by the social scientists.

The consequence that this critique from within yields for the social scientist is that *s/he* feels, in the first instance, speechless. Being confronted to critique from within troubles at first the analytical posture of STS scholars. How to react to an actor’s own craft to reflect, question, and criticise? Are these critical reflexivities simply an actor’s self-deception of difference, merely a rhetorical commitment? Or, on the contrary, do these critical reflexivities solve all problematic normative dimensions of biomedical practices? Do they make STS redundant in these contexts? Rather than dismissing these critiques as merely rhetoric, benign and inconsequential (cf. Latour 2004), we propose to empirically investigate and analytically approach these practices, especially when it becomes clear that they are not simply an artefact of interviewing, but rather translate into concrete alternatives of technoscientific practice that pre-dated the arrival of the STS scholar.¹¹

In fact, in addition to being voiced by the expert – which is the first defining feature of ‘critique from within’ – this critique also has a substantive practical reach: what we consider the second of its defining features. These enactments of critique are not merely a rhetorical, or at best discursive commitment. Marie Dupont and Eva Doblinger exemplify, rather, how the recognition of the biases, errors and suffering engendered by science, technology and the medical domain can translate into novel practical configurations of these fields. To be clear, again, the credit of these socio-technical alternative configurations still depends on their abidance to the material and theoretical contrivances of Marie Dupont and Eva Doblinger’s respective fields. While narrated as novel and digressive configurations from mainstream forms of knowledge-making and provisions of healthcare, these practices stay within the limits of their disciplines. Yet, these configurations are different enough to ground alternative social, political and ethical practices and realities. Experts who have taken note of the perpetuation of power relations through mainstream biomedical practices develop here projects in place of routinary approaches that have the very explicit intention to remedy or at least mitigate the problems of mainstream practices.¹² Critique from within is, thus, *within* in a second sense: It consists of an analysis of the biases, errors and suffering of mainstream practices that translates into concrete, situated, local constructions of socio-technical material alternatives by a group of experts. It is a two-tiered enactment.

Critique from within reveals that biomedical experts can present a coherent analysis of the perpetuation of power relations and suffering through the mainstream practices in their fields. A form of critique that, although moving from different premises, is akin to the analysis the STS scholar would be inclined to make. Does this leave the STS scholar speechless? In other words, what is it then that the STS scholar can still add? Is critique from within an alternative, a replacement, or an opportunity for STS scholarship? What is it, if anything, that STS can add?

Eva Doblinger’s SupportivNET-project and its effects

When Anna met Eva Doblinger in 2016, she was working as a senior physician in the nephrology department of the *City Hospital*, one of several communal hospitals in a

larger town in Austria. Unlike the city's prestigious university hospital's nephrology department which had a transplant centre and hosted a lot of clinical research, the *City Hospital's* nephrology department consisted only of an internal ward, an outpatient clinic, and a dialysis unit. Having started working in the *City Hospital* as a nephrology resident in the 1990s, Doktor Doblinger was in 2016 leading the dialysis unit. Dialysis is the extraction of waste products such as calcium, potassium and urea, and excess fluids from the blood. It replaces lost kidney function. In the form of haemodialysis, which is the most widespread treatment modality, it is performed with a haemodialysis machine three times a week for four hours in a dialysis unit. The patients whose kidney function is replaced in Austria as elsewhere in Europe are mostly in their late 60s and 70s and have entered renal failure due to type 2 diabetes, hypertension and/or adipositas. As the treatment is a highly taxing procedure for the body, patients age rapidly. Life expectancy on haemodialysis in 2016 in Austria was approximately 2 years (Österreichische Gesellschaft für Nephrologie 2016).

Haemodialysis four hours three times a week was the treatment that was provided day after day in the dialysis unit of the *City Hospital*. Every morning, when the first round of about 15 patients arrived in the unit, the dialysis nurses connected patients' catheter or fistula to lines that led to the haemodialysis machines, discussed with them the amount of fluid to be extracted during the dialysis run, and started the run. Eva Doblinger or the junior physician working in the unit, then, came to see the patients during their run, asked how they were doing and discussed minor and major issues. After four hours, the nurses disconnected from the haemodialysis machine the patients, who would return two days later for the same procedure, in a cycle of runs and breaks, to be repeated over and over again. By providing haemodialysis to around 65 patients whose kidneys had stopped functioning, day after day nephrologists and dialysis nurses sustained these patients' lives. By employing technologies, they performed the archetypical form of modern biomedicine: curing disease or, if this is not possible, keeping bodies alive for as many years and days as possible.

Parallel to this routine of providing life-prolonging haemodialysis, Doktor Doblinger had responded to the technical innovation of the haemodialysis machine. More specifically, she had responded to the context within which this technology is put to use having changed drastically. Differently from the 1950s and 1960s the haemodialysis machines were no longer a prerogative of a couple of centres in Europe and Northern America that used them to stave off the death of young adults who had entered renal failure due to mercury poisoning or illegal abortions. Nowadays, haemodialysis machines were available all over Europe for the treatment of a, as already mentioned above, elderly, often frail and multi-morbid patient population. What Doktor Doblinger had done was to set up a project in the dialysis unit of the *City Hospital* for the provision of a different kind of health care. She had called the project at first 'palliative renal replacement therapy', but the word 'palliative' had evoked, so she relayed to Anna, too many associations with death and dying. She had, thus, quickly changed it to 'supportive renal replacement therapy', SupportivNET, thus referring to the non-invasive treatment of renal failure through medication and diet. Doktor Doblinger had come to develop the project when she had rotated to the inpatient ward, which is where dialysis and other patients become admitted when their health status deteriorates. It is a ward where, on average, one patient dies every week. There, she saw that patients who would pass

away soon were not informed about the approaching end of their life. In parallel, nurses were relieved when a patient who was in the process of dying had not passed away during their shift. The SupportivNET project's aim was to change the classical treatment goal of 'quantity of life' to 'quality of life' and 'reduction of suffering' for all those patients for whom, due to their age and/or co-morbidities, according to international data, this prolongation of life was not or only minimally achievable. As stated by the project proposal, this aim was broken down into four points:

1. Identification of patients for whom an initiation or a continuation of dialysis does not provide an advantage of prolonging life
2. Planning of future therapy with the sole goal to improve quality of life
3. Inclusion of the patient in the planning of such therapy through 'shared decision making'
4. Planning ahead and documentation of the patient's wishes regarding his/her end of life ('advance care planning')

Thus, in 2016, next to standard haemodialysis treatment for four hours three times a week for 65 patients, Doktor Doblinger and her colleagues were also providing supportive renal replacement therapy to five patients. This implied in the case of one patient a dialysis length of three hours two times a week, for another patient instead of a definitive initiation of standard dialysis a trial-and-error period of three months, and in the case of yet again another one a withdrawal of dialysis altogether.

Doktor Doblinger had come to recognise how the standard use of life-prolonging technologies lead to 'death deviance' (Timmermans 1999, 6) and produced 'ruined deaths' (Oudshoorn 2020, 235) just like science and technology scholars had critically pointed out. She had noticed the immense toll that was put on nurses when they were expected to use medical technologies to continue life-prolonging therapies to dying patients and the work that was needed on behalf of medical professionals to make the use of technologies in such circumstances 'meaningful' – again, a point of critique that exists in social sciences literature since the 1960s (Glaser and Strauss 1965; Sudnow 1967). Not only had she come to critique the immense suffering caused through the standard use of technologies to prolong life at all costs and in any kind of circumstance in health care just like STS and social science scholars had done again and again (e.g. Chan et al. 2018; Chapple 2010; Kaufman 2005). She had come to set up a different use of technologies engendering an alternative form of modern biomedicine: caring for bodies as they deteriorate and decline and, instead of focusing solely on the prolongation of life, enabling one with the highest possible quality for the days left. Like Marie Dupont in her lab, Doktor Doblinger had questioned the mainstream biomedical practice and had set up a sociotechnical, material, critical alternative to mainstream nephrology and biomedicine more generally. When returning from a stretch of fieldwork in the *Mountain Hospital* where no supportive renal replacement therapy programme had been set up, Anna remarked in front of Doktor Doblinger: 'It's hard to die there'. Doktor Doblinger promptly corrected her, encapsulating her discontent with the strong biomedical focus on extending life at all costs: 'It's hard to die everywhere!' Anna, who, in the line of the fourth repertoire of critique, had hoped to articulate alternative practices that were verbally unavailable to practitioners themselves, was, in the face of

this expert who questioned mainstream practices more radically than she did, lost for words.

When confronted with biomedical professionals who themselves voice how mainstream practices have built-in errors, are questionable on normative grounds and produce suffering – the argument that STS scholars and social scientists have put forward repeatedly – we found little meaning in perpetuating these arguments. What began to catch our attention in the face of critique from within was instead how practising a critical alternative yielded concrete, specific, socio-material effects. Two of these types of effects we draw out in the following, because they are central to the way in which STS, we would argue, might engage with critical alternatives. We will illustrate them through the example of the supportive renal replacement therapy program running in the *City Hospital*. Let us introduce the first type of effects. These are effects that are not necessarily positive:

Fieldnotes, 6th June 2017, annual conference of the European Renal Association, a conference centre, Madrid

Doktor Dobliger is leaving the room, in which she and I just attended a panel on ‘palliative care’ in nephrology. “The last talk was good, but I missed the issue of language. I had a patient from Egypt once,” she begins. “I wanted to withdraw her dialysis. She would have been able to still visit her children and grandchildren. But I couldn’t find a way to get to her. At some point, I met her daughter who explained that withdrawing dialysis would mean for her Muslim mother ending up in hell! So I thought, ‘Well, maybe better not!’”

Running the SupportivNET in the dialysis unit in the *City Hospital* included organising a ‘shared decision making’ process, which meant offering different options to patients: to continue standard life-prolonging haemodialysis four hours three times a week or to reduce/withdraw dialysis treatment. This yielded problematic consequences. Presenting patients with this ‘choice’ not only framed vulnerable people with erratic bodies as ‘consumers’ who chose a product on a market that they liked or as ‘citizens’ who were in control of their bodies and governed themselves and others (Mol 2008). More importantly, in this ‘conduct of conduct’ (Rose 1990), not all patients were equally able to freely opt for, what staff considered, the ‘sensible’, meaning supportive treatment. The elderly lady from Egypt and her unwillingness to withdraw from life-prolonging dialysis for religious reasons exemplifies how patients with different religious, cultural or social background aligned differently with health care options that the staff considered ‘futile’ and ‘costly’. Middle class, educated, white patients were in fact more likely to opt out of life-prolonging treatment in the dialysis unit in the *City Hospital* like in other places (Livne 2019). Although Anna did not observe health care staff starting to explicitly classify patients, a differentiation emerged between patients who were ‘rationally’ choosing to reduce futile treatment and those who acted ‘irrationally’. This might have quickly slipped into an unspoken distinction between ‘good’ and ‘bad’ patients. Running the SupportivNET program by enacting a shared decision-making process did not simply offer patients a ‘free choice’. It rather engendered differentiation among them, which in turn potentially reproduced and perpetuated social and/or cultural differences as well as inequalities in health care.

Next to negative effects, there are others that are less problematic. Carrying out the program not only changed the treatment and care that nurses and nephrologists were

offering to their patients but also reconfigured the relationship between nursing and medical practices. Let us re-join the unit:

Fieldnotes, 21st March 2017, dialysis unit, The City Hospital

It is 9.30 o'clock. In the social room have gathered for the daily ward round: Doktor Doblinger (the physician on duty today), nurse Angelika, nurse Brigitte, nurse Rudolf and nurse Susanne (the nursing staff equally on duty this morning), nurse Rebecca (the head nurse) and nurse Marietta (the vice head nurse). We are sitting around the long table. Rebecca, at the head of the table, closes the shift rooster, clears her throat, and states, "Good." The chatter dies down and nurse Angelika begins presenting the first patient, "Herr Piatnik – nothing. Herr Fialka – he has an eczema." Doktor Doblinger responds, "I have prescribed Tavokort, a salve with cortisol." Nurse Brigitte continues, "Frau Schöbel – her fistula is gushing. She changed the bed linens yesterday and tended her garden even." Everybody nods. "Frau Novak – nothing." And so the round continues.

As part of the supportive renal replacement therapy program, bimonthly 'supportive meetings' had been introduced to identify patients who were too old and/or multi-morbid to benefit from standard life-prolonging haemodialysis treatment. These meetings had a particular format inspired by the project's objectives. To move from a 'paternalistic' to an 'interdisciplinary' mode of interaction, the meetings were not held at the bedside of patients or in the corridor, not with a lot of medical staff and solely the head nurse being silently present while doctors discussed 'medical cases'. Instead, the meetings took place in the nurses' social room on the ward, around a long table, with one or two doctors present, and all nurses on duty attending, including the head nurse or the vice head nurse, or both. Of note, in this setting, the nurses were given the central task to present the patients to the rest of the team. This interdisciplinary work format was not only used during the 'supportive meetings' that took place every other month though. As it happened, it became the standard format for the daily ward rounds as well, as the fieldnotes from such a ward round meeting on an ordinary Tuesday morning above exemplify. It took place in a sitting format with nursing staff outnumbering medical staff and presenting patients in a narrative form. With this change in daily interactions between professional groups in the ward came a change with regard to the centrality of medical knowledge about pathophysiology, diagnosis, and pharmacological and other treatments. This knowledge was no longer leading the conversation. Rather, bodily, embodied, experiential and tacit knowledge about the patient, which the nurses had collected, found its way into the daily assessments. The 'gushing' of a fistula that a nurse had felt while connecting a patient to the dialysis machine, or the informal knowledge about patients' lives – such as the activities they had pursued the previous days – all became an integral part of patient assessments. Due to the reconfiguration of practice inaugurated with the SupportivNET, medical knowledge became complemented by highly valuable nursing knowledge (e.g. Mesman 2008; Pijkeren, Wallenburg, and Bal 2021), which would have otherwise remained unattended to and rendered invisible (Star and Strauss 1999) in clinical decision making. Running the SupportivNET-project had improved in this way the health care that was provided not only to those patients who were part of the project, but also to all the others taken care of within the unit.

Second intermezzo: critical alternatives: collateral goods and bads

Some experts observe the biased, power-related and oppressive implications of their mainstream practices and build socio-material, critical alternatives to these mainstream practices. These can take the form of an experimental protocol or a pilot clinical project, which carry out these critical alternatives and yield specific, concrete, situated effects. These effects are not only the intended goals of the experiments or projects. There are also effects that arise unintentionally and along the way. John Law, starting from the assumption that realities are not given, but that practices perform realities, has called attention to the ways in which practices enact realities ‘quietly, incidentally and along the way’ (2009, 1). To capture these kinds of effects, he has introduced the notion of ‘collateral’ realities (2009). Building on John Law, we suggest calling the effects that critical alternatives set up by experts yield ‘collateral’ effects. Coupled with the insight of critique from within, a focus on collateral effects invites attending to the local specificities and consequences that characterise the non-trivial matter of re-assembling the realities of technoscience. Under this view, critical STS scholarship adds then to its traditional concern of dissecting the collateral realities of technoscience, the task of bringing out the collateral effects produced by critique from within to produce socio-technical change.

As the SupportivNET exemplifies,¹³ running critical alternatives yields at least two types of collateral effects. There are effects that are highly problematic and may even be obnoxious. The case of SupportivNET shows how the enactment of a ‘shared decision-making’ in a clinical setting led to a (potential) differentiation between those patients who made a ‘sensible’ choice (by foregoing or withdrawing treatment that staff considered futile) and those who didn’t. By doing so, it came to (potentially) perpetuate social inequalities within the health care system. The project shows, however, that there are positive effects as well. The SupportivNET-project led to a change in the daily routines in the ward. Through more equal interprofessional communication and the inclusion of valuable nursing knowledge, the quality of care that was delivered improved not only for those patients who received care and treatment within the frame of the project – but for all of them. As argued by Annemarie Mol (2002), the ways practices enact in different ways one disease entail enacting differently the ‘bads’ and ‘goods’ of these lived conditions (176–177). In a similar vein, we wish to underline that carrying out critical alternatives from within yields ‘collateral bads’ and ‘collateral goods’.

We argue that when experts themselves critique mainstream practices in their field and run socio-material critical alternatives in their settings, the STS scholar neither has to remain speechless nor just reiterate the critique the experts (and other STS scholars) have already voiced. Rather, this situation is a possibility to study critique as it gets enacted and taken up, to highlight what needs to be re-assembled, or even mitigated in these processes, and to unpack the effects critique in a given setting actually yields. It, thus, offers the unique opportunity to partake in a process of socio-technical innovation.

What is most urgent, we would like to suggest, is to attend to and systematically bring out these specific, concrete, situated effects, the collateral bads and goods, that these critical alternatives yield. By doing so, we believe, critique from within adds to what STS has been doing all along: empirically investigating and critically analysing the effects of science and technology in society. The novelty lies in a specific focus on the generative

affordances of critique that do not originate in the doing, writing, and thinking of STS. We expand on what this offers to R(R)I in the following.

Discussion

In this paper, we have argued that there exists a largely understudied form of critique in STS, which we have called ‘critique from within’. Critique from within is, as we brought out above, a two-tiered enactment. First, it consists of an analytical uptake, on the side of the actors, of the biases, errors, limitations, implications, and potential suffering that result from mainstream scientific or biomedical practices. In a different idiom and from different premises than critical scholarship, actors may have realised that their technoscientific practices are far from neutral. Actors may produce critical discourses about the problematic social dimensions of their practice. Second, such critique from within is also a thoroughly pragmatic endeavour: beyond discourse, it translates into concrete, situated, local constructions of sociotechnical material alternatives by a group of experts. Such critique is then enacted in an alternative material-semiotic hybrid of biomedical research or care practice, with its own specific characteristics and objectives, with specific technical and scientific affordances that are supposed to reverberate into particular (alternative) social and political agendas. Being it an alternative configuration of an epigenetics lab’s experimental systems or the supportive care programme of a nephrology ward, critique generates an alternative *from within* the boundaries of those biomedical settings.

Critique from within, we have argued, calls for an addition to the analytical readout of the STS scholar and makes, we believe, STS perspectives even more relevant in the study of technoscience. As we argued above, critique from within yields both collateral goods and bads (Law 2009; Mol 2002). It is therefore important to underline that critique from within is far from being a waiver of adversarial scrutiny, or an uncritical incorporation of the actors’ claims into STS analysis. Critique from within rather demands scrutinising the ontological politics of built alternatives (Law 2009). It not only casts light onto how practices may become at times different from the mainstream, all the while maintaining their status of being internal practices to science and biomedicine. It shows first and foremost the effects that arise if biases and suffering are sought to be mitigated by practitioners themselves. It is, thus, a call to pay attention to the ongoing crafts and reflexivities of the critique-inspired collateral realities of technoscience.

Most importantly, critique from within offers a novel way of engaging with R(R)I. R(R)I practices may invite looking at the micro-politics and the tacit hierarchies, biases and assumptions which dominate technoscience. Or they may be revelatory of unacknowledged power dynamics of technoscience in society when they take the shape of ELSA studies. Or they can be brought closer to generating novel perspectives on innovation when they build on the mutual engagement of social sciences and STEM perspectives (Felt 2018). As Von Schomberg (2011, 9) argues, R(R)I can also be an interactive process that brings critical scholars, societal actors and innovators together to produce sustainability of innovation processes. In contrast, and taking up the idea of critique from within, the task of R(R)I might become less to *create* responsibility conditions (Felt 2017) for technoscientific innovation than to *point out* the specific craft of those who have set up such conditions in their day-to-day practice. Rather than asking how

to foster the experts' willingness to include wider societal values and concerns in technoscience, the approach to R(R)I inspired by critique from within might be a proactive engagement *with* those critical actors who work on alternatives in science, technology and the medical domain on a daily basis. This implies in a first instance a systematic reckoning with and seeking out of actors who already, and from within their practice, question the standard practices in their fields. We are, certainly, not the first to record the 'many forms of 'bottom-up responsibility' [that] are immanent to the everyday work of scientists' (Glerup, Davies, and Horst 2017, 321). However, our analytical emphasis on critique from within is a reminder that scientists' *de facto* responsibilities can be productively engaged with beyond the institutional landscape and the governance of science. Rather, these responsibilities may be also productive and generate changes led by the actors, which can make up alternative sociotechnical configurations of science, medicine and technology. When translated into a concrete R(R)I initiative, critique from within might therefore reckon with the possibility that experts might already have set up responsibility practices in their fields that call for attending to the specific collateral bads and goods yielded by these responsibility practices.

STS researchers have long shown that technoscience is a gamut of epistemic, technological and value-laden practices that can be best understood from gaining insight situated within these specific settings. A myriad of agents, engagements, and reflexivities take part in these sociotechnical processes. What we have argued here is that some actors question the taken-for-granted features of science and technology and enact critical insights within the boundaries of the field. For them, we need a more modest approach to the critical entanglements between science, innovation, technologies and the medical domain, which requires abandoning critique as a prerogative of codified disciplinary scholarship. Critique from within then becomes the analytical lens that could magnify the potential and pitfalls of these practices for responsible research and innovation in society.

Notes

1. We build on the definition of R(R)I proposed by von Schomberg as 'a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of an innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).' (Von Schomberg 2013, 19) We are using the acronym R(R)I without any specific commitment to rival definitions of responsible innovation. We consider it the most inclusive version representing both Responsible Innovation and Responsible Research and Innovation.
2. The Kuhnianization and/or Latourization of STS (we owe the formula to Lynch 2012) has been the hallmark of the field for several decades. However, in the last two decades, it has admittedly run out of steam, as Latour deplors in his later work (2004). These radical anti-realist stances fuel too often into strategies to adverse 'truth', instead of constituting critique of an idealistic version of science. Thus, Latour's later work is an invitation to re-orient STS critique away from these matters of fact towards so-called matters of concern.
3. Jörg Niewöhner (2015) has distinguished 'collaborations', in which the aim is an interdisciplinary shared outcome, from 'co-laborations' in which joint, non-teleological epistemic work produces disciplinary reflexivity. In contrast, Felicity Callard and Des Fitzgerald

- (2015) have introduced the notion of ‘experimental entanglement’ to emphasize the openness and, thus, excess that engagements with natural scientists hold. For an overview over the debates on interdisciplinarity, STS and critique see Callard and Fitzgerald (2015).
4. Following Swiss regulation, the project did not require any specific ethics approval, besides the validation of a data management plan (approved by the Swiss National Science Foundation).
 5. A previous publication by Luca reports more extensively on this bit of fieldwork (Chiapperino 2021). The publication documents how scientists navigate the tension of doing a post-genomic science (i.e. a science that studies openness to the environment and the plasticity of biology) while feeding into problematic individual-oriented representations of body-environment traffic, biology and health.
 6. Following Austrian law, an ethics approval was deemed exempt.
 7. For a detailed analysis, drawing on a care-in-practice approach, on the ways in which in mundane goings-on in a dialysis unit quality of life is improved, see Mann (2021).
 8. We refer to the original publication firstly reporting on these observations (Chiapperino 2021) for considerations about the artificiality and language slippages that belong to the practice of studying complex psychosocial phenomena, such as human stress in the highly artificial and controlled conditions of the behavioural epigenetics lab. For the complex relations between words and practices, see Mann and Mol (2019).
 9. This is one definition of ‘reflexivity’ next to many others that have been developed in STS. For a discussion of forms of ‘reflexivity’ in responsible innovations, see Stirling (2006); science and technology studies more generally, see Lynch (2000).
 10. The distinction between ‘inside’ and ‘outside’, ‘emic’ and ‘etic’, is itself not stable. For an analysis of the relation between the social scientific observer and the world she observes, arguing for attention to the ever-shifting relations between the two, an ‘emetic’ position, see Bruun Jensen (2019).
 11. As we are going to explore in the second intermezzo, critique from within crucially adds to the productive and generative affordances of STS scholarship.
 12. While Marie Dupont exemplifies how a biomedical expert leading a group in a prestigious institution voices critique, Eva Doblinger, as will become clear in the next section, shows how a practitioner who neither works in a distinguished place nor heads an entire department is equally able to question mainstream practices. How biomedical experts enrol others for the enactment of alternative socio-material practices is, thus, a question to investigate empirically. For an analysis of the case of Eva Doblinger, see Mann (forthcoming).
 13. For a kin analysis of (what we call here) the collateral effects of the use of environmental enrichment in the UoS lab, the reader can consult Chiapperino 2021, 61–63.

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References

- Akrich, Madeleine. 1992. “The De-Description of Technical Objects.” In *Shaping Technology/ Building Society. Studies in Sociotechnical Change*, edited by Wiebke E. Bijker and John Law, 205–224. Cambridge/Mass., London: MIT Press.
- Blok, V., and P. Lemmens. 2015. “The Emerging Concept of Responsible Innovation. Three Reasons Why It Is Questionable and Calls for a Radical Transformation of the Concept of Innovation.” In *Responsible Innovation 2: Concepts, Approaches, and Applications*, edited by Bert-Jaap Koops, Ilse Oosterlaken, Henny Romijn, Tsjalling Swiwestra, and Jeroen Van Den Hoven, 19–35. Cham: Springer International Publishing.
- Boeninck, Marianne, and Olya Kudina. 2020, September 1. “Values in Responsible Research and Innovation: From Entities to Practices.” *Journal of Responsible Innovation* 7 (3): 450–470. <https://doi.org/10.1080/23299460.2020.1806451>.

- Bohacek, Johannes, and Isabelle M. Mansuy. 2015, September 29. "Molecular Insights Into Transgenerational Non-Genetic Inheritance of Acquired Behaviours." *Nature Reviews Genetics* 16 (11): 641–652. <https://doi.org/10.1038/nrg3964>.
- Bruun Jensen, Caspar. 2019. "Vertiginous Worlds and Emetic Anthropologies." In *The World Multiple. Quotidian Politics of Knowing and Generating Entangled Worlds*, edited by Keiichi Omura, Grant Jun Otsuki, Shiho Satsuka, and Atsuro Morita, 37–51. Abingdon: Routledge.
- Callard, Felicity, and Des Fitzgerald. 2015. *Rethinking Interdisciplinarity Across the Social Sciences and Neurosciences*. Basingstoke, Hampshire; New York, NY: Palgrave Macmillan UK. <https://www.palgrave.com/gp/book/9781137407955>.
- Chan, Lisa S., Mary Ellen Macdonald, Franco A. Carnevale, and S. Robin Cohen. 2018. "I Am Only Dealing with the Acute Issues': How Medical Ward 'Busyness' Constrains Care of the Dying." *Health* 22 (5): 451–468. <https://doi.org/10.1177/1363459317708822>
- Chapple, Helen Stanton. 2010. *No Place for Dying. Hospitals and the Ideology of Rescue*. Oxon, NY: Routledge.
- Chiapperino, Luca. 2021, March 1. "Environmental Enrichment: An Experiment in Biosocial Intervention." *BioSocieties* 16 (1): 41–69. <https://doi.org/10.1057/s41292-019-00181-5>.
- Chung, Emma, John Cromby, Dimitris Papadopoulos, and Cristina Tufarelli. 2016, March 1. "Social Epigenetics: A Science of Social Science?" *The Sociological Review Monographs* 64 (1): 168–185. <https://doi.org/10.1002/2059-7932.12019>.
- Day, Jeremy J. 2014, September. "New Approaches to Manipulating the Epigenome." *Dialogues in Clinical Neuroscience* 16 (3): 345–357. <https://doi.org/10.31887/DCNS.2014.16.3/jday>
- Dussauge, Isabelle, Claes-Fredrik Helgesson, and Francis Lee. 2015. *Value Practices in the Life Sciences and Medicine*. Oxford: Oxford University Press.
- Fassin, Didier, ed. 2012. *A Companion to Moral Anthropology*. Hoboken, NJ: Wiley-Blackwell.
- Felt, Ulrike. 2017. "'Response- Able Practices' or 'New Bureaucracies of Virtue': The Challenges of Making RRI Work in Academic Environments." In *Responsible Innovation 3: A European Agenda?*, edited by Lotte Asveld, Rietje van Dam-Mieras, Tsjalling Swierstra, Saskia Lavrijssen, Kees Linse, and Jeroen van den Hoven, 49–68. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-64834-7_4
- Felt, Ulrike. 2018. "Responsible Research and Innovation." In *In Handbook of Genomics, Health and Society*, edited by Sarah Gibbon, Barbara Prainsack, Stephen Hilgartner, and Janette Lamoreaux, 108–116. London/New York: Routledge. <https://doi.org/10.4324/9781315451695>
- Fitzgerald, Des, and Felicity Callard. 2015, January. "Social Science and Neuroscience Beyond Interdisciplinarity: Experimental Entanglements." *Theory, Culture & Society* 32 (1): 3–32. <https://doi.org/10.1177/0263276414537319>.
- Foucault, Michel. 1986. "Of Other Spaces." *Diatrics* 6 (1): 22–27.
- Glaser, Barney, and Anselm Strauss. 1965. *Awareness of Dying*. Brunswick, London: Aldine Transaction.
- Glerup, Cecilie, Sarah R. Davies, and Maja Horst. 2017. "'Nothing Really Responsible Goes on Here': Scientists' Experience and Practice of Responsibility." *Journal of Responsible Innovation* 4 (3): 319–336. <https://doi.org/10.1080/23299460.2017.1378462>.
- Hannan, Anthony J. 2014, February. "Environmental Enrichment and Brain Repair: Harnessing the Therapeutic Effects of Cognitive Stimulation and Physical Activity to Enhance Experience-Dependent Plasticity." *Neuropathology and Applied Neurobiology* 40 (1): 13–25. <https://doi.org/10.1111/nan.12102>.
- Hillersdal, L., A. P. Jespersen, B. Oxlund, and B. Bruun. 2020. "Affect and Effect in Interdisciplinary Research Collaboration." *Science & Technology Studies* 33 (2): 66–82. <https://doi.org/10.23987/sts.63305>.
- Jerak-Zuiderent, Sonia. 2015. "Keeping Open by Re-Imagining Laughter and Fear." *The Sociological Review* 63 (4): 897–921. <https://doi.org/10.1111/1467-954X.12221>.
- Kaufman, Sharon. 2005. *... and a Time to Die. How American Hospitals Shape the End of Life*. Chicago: University of Chicago Press.
- Landecker, Hannah, and Aaron Panofsky. 2013, July 30. "From Social Structure to Gene Regulation, and Back: A Critical Introduction to Environmental Epigenetics for Sociology."

- Annual Review of Sociology* 39 (1): 333–357. <https://doi.org/10.1146/annurev-soc-071312-145707>.
- Latour, Bruno. 2004. “Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern.” *Critical Inquiry* 30 (2): 225–248. <https://doi.org/10.1086/421123>
- Latour, Bruno, and Steve Woolgar. 1986. *Laboratory Life: The Construction of Scientific Facts*. Princeton University Press.
- Law, John. 2004. *After Method: Mess in Social Science Research*. 1st edition. London: New York: Routledge.
- Law, John. 2009. “Collateral Realities.” December 29. <http://www.heterogeneities.net/publications/Law2009CollateralRealities.pdf>.
- Livne, Roy. 2019. *Values at the End of Life. The Logic of Palliative Care*. Cambridge/Mass: Harvard University Press.
- Lock, Margaret. 2013, July. “The Epigenome and Nature/Nurture Reunification: A Challenge for Anthropology.” *Medical Anthropology* 32 (4): 291–308. <https://doi.org/10.1080/01459740.2012.746973>.
- Lynch, Michael. 2000. “Against Reflexivity as an Academic Virtue and Source of Privileged Knowledge.” *Theory, Culture & Society* 17 (3): 26–54. <https://doi.org/10.1177/02632760022051202>.
- Lynch, Michael. 2012. “Self-Exemplifying Revolutions? Notes on Kuhn and Latour.” *Social Studies of Science* 42 (3): 449–455. <https://doi.org/10.1177/0306312712439120>
- Mann, Anna. 2021. “Abandoning Questionnaires: Improving Quality of Life in Daily Nephrology Practice.” *Nordic Journal of Science and Technology Studies* 9 (1): 53–63. <https://doi.org/10.5324/njsts.v9i1.3545>
- Mann, Anna. Forthcoming. “To Improve Quality of Life’. Diverging Enactments of a Value in Nephrology Clinical Practices.” *Health. An Interdisciplinary Journal*.
- Mann, Anna, and Annemarie Mol. 2019. “Talking Pleasures, Writing Dialects: Outlining Research on Schmecka.” *Ethnos* 84 (5): 772–788. <https://doi.org/10.1080/00141844.2018.1486334>
- Mesman, Jessica. 2008. *Uncertainty in Medical Innovation. Experienced Pioneers in Neonatal Care*. Hampshire, NY: Palgrave.
- Mol, Annemarie. 2002. *The Body Multiple. Ontology in Medical Practice*. Durham, London: Duke University Press.
- Mol, Annemarie. 2006a. “Proving or Improving: On Health Care Research as a Form of Self-Reflection.” *Qualitative Health Research* 16 (3): 405–414. <https://doi.org/10.1177/1049732305285856>
- Mol, Annemarie. 2006b. “Koning schaak. Mannen prijzen als stijloefening.” *Tijdschrift voor Genderstudies* 9 (3): 63–78.
- Mol, Annemarie. 2008. *The Logic of Care: Health and The Problem of Patient Choice*. Milton Park and New York: Routledge.
- Mol, Annemarie, Ingunn Moser, and Jeannette Pols. 2010. *Care in Practice: On Tinkering in Clinics, Homes and Farms*. Bielefeld: transcript.
- Moser, Ingunn. 2010. “Perhaps Tears Should Not Be Counted but Wiped Away: On Quality and Improvement in Dementia Care.” In *In Care in Practice: On Tinkering In Clinics, Homes and Farms*, edited by Annemarie Mol, Ingunn Moser, and Jeannette Pols, 277–300. Frankfurt am Main: transcript.
- Naidoo, Vinogran, Olaia Martínez-Iglesias, and Ramón Cacabelos. 2022. “Chapter 20 - Targeting Epigenetics as Future Treatments of Trauma- and Stress-or-Related Disorders. Epidrugs and Epinutraceuticals.” In *In Epigenetics of Stress and Stress Disorders*, edited by Nagy A. Youssef, Vol. 31, 317–392. Translational Epigenetics. Academic Press. <https://www.sciencedirect.com/science/article/pii/B9780128230398000125>.
- Nelson, Nicole. 2016, March 1. “Model Homes for Model Organisms: Intersections of Animal Welfare and Behavioral Neuroscience Around the Environment of the Laboratory Mouse.” *BioSocieties* 11 (1): 46–66. <https://doi.org/10.1057/biosoc.2015.19>.
- Niewöhner, Jörg. 2015, April 3. “Epigenetics: Localizing Biology Through Co-Laboration.” *New Genetics and Society* 34 (2): 219–242. <https://doi.org/10.1080/14636778.2015.1036154>.

- Niewöhner, Jörg. 2016. "Yhteistyöstävä Antropologia: Kuinka edistää refleksiivisyyttä [Collaborative anthropology: Crafting reflexivities experimentally]." In *Etnologinen tulkinta ja analyysi: Kohti avoimempaa tutkimusprosessia [Ethnological interpretation and analysis: Towards a transparent research process]*, edited by J. Jouhki and T. Steel. 81–125. Helsinki: Ethnos.
- Österreichische Gesellschaft für Nephrologie. 2016. Nierenersatztherapie 2016. Vorläufige Daten. www.nephro.at retrieved on the 8th August 2018.
- Oudshoorn, Nelly. 2020. *Resilient Cyborgs: Living and Dying with Pacemakers and Defibrillators*. Singapore: Palgrave Macmillan.
- 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. <https://doi.org/10.1093/scipol/scs093>.
- Owen, Richard, René von Schomberg, and Phil Macnaghten. 2021, May 4. "An Unfinished Journey? Reflections on a Decade of Responsible Research and Innovation." *Journal of Responsible Innovation* 8 (2): 217–233. <https://doi.org/10.1080/23299460.2021.1948789>.
- Pijkeren, Nienke van, Iris Wallenburg, and Roland Bal. 2021. "Triage as an Infrastructure of Care: The Intimate Work of Redistributing Medical Care in Nursing Homes." *Sociology of Health & Illness* 43 (7): 1682–1699. <https://doi.org/10.1111/1467-9566.13353>
- Pols, Jeannette. 2004. "Good Care: Enacting a Complex Ideal in Long-Term Psychiatry." PhD thesis, University of Twente.
- Pols, Jeannette. 2005. "Enacting Appreciation: Beyond the Patient Perspective." *Health Care Analysis* 13 (3): 203–221. <https://doi.org/10.1007/s10728-005-6448-6>
- Popa, Eugen Octav, Vincent Blok, and Renate Wesselink. 2020, January 1. "Discussion Structures as Tools for Public Deliberation." *Public Understanding of Science* 29 (1): 76–93. <https://doi.org/10.1177/0963662519880675>.
- Rabinow, Paul, and Nikolas Rose. 2006, June. "Biopower Today." *BioSocieties* 1 (2): 195–217. <https://doi.org/10.1017/S1745855206040014>.
- Randles, Sally, Philippe Larédo, Allison Marie Loconto, Bart Walhout, and Ralf Lindner. 2016. "Framings and Frameworks: Six Grand Narratives of de Facto RRI." In *Navigating Towards Shared Responsibility in Research and Innovation. Approach, Process and Results of the Res-AGorA Project*, np. Fraunhofer Institute for Systems and Innovation Research (ISI). <https://hal.science/hal-01320462>.
- Rose, Nicolas. 1990. *Governing the Soul: The Shaping of the Private Self*. London: Routledge.
- Sandi, Carmen, and József Haller. 2015. "Stress and the Social Brain: Behavioural Effects and Neurobiological Mechanisms." *Nature Reviews Neuroscience* 16 (5): 290–304. <https://doi.org/10.1038/nrn3918>.
- Schomberg, Von, René, and J. Hankins, eds. 2019. *The International Handbook on Responsible Innovation. A Global Resource*. 12–32. Cheltenham and Northampton: Edward Elgar Publishing.
- Schön, Donald A. 1984. *The Reflective Practitioner: How Professionals Think In Action*. 1st ed. New York: Basic Books.
- Shanley, D. 2022. *Making Responsibility Matter: The Emergence of Responsible Innovation as an Intellectual Movement*, 249. Maastricht: Maastricht University. <https://doi.org/10.26481/dis.20221208ds>
- Singleton, Vicky. 2010. "Good Farming: Control or Care?" In *In Care in Practice: On Tinkering In Clinics, Homes and Farms*, edited by Annemarie Mol, Ingunn Moser, and Jeannette Pols, 235–257. Frankfurt am Main: transcript.
- Smolka, Mareike. 2020a, April 1. "Generative Critique in Interdisciplinary Collaborations: From Critique in and of the Neurosciences to Socio-Technical Integration Research as a Practice of Critique in R(R)I." *NanoEthics* 14 (1): 1–19. <https://doi.org/10.1007/s11569-019-00362-3>.
- Smolka, Mareike, Erik Fisher, and Alexandra Hausstein. 2020b, November 25. "From Affect to Action: Choices in Attending to Disconcertment in Interdisciplinary Collaborations." *Science, Technology, & Human Values*. 0162243920974088. <https://doi.org/10.1177/0162243920974088>.
- Star, Susan Leigh, and Anselm Strauss. 1999. "Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work." *Computer Supported Cooperative Work* 8 (1-2): 9–30. <https://doi.org/10.1023/A:1008651105359>

- Stilgoe, Jack, and David H. Guston. 2017. "Responsible Research and Innovation." In *The Handbook of Science and Technology Studies*, edited by Felt Ulrike, Rayvon Fouché, Clark A. Miller, and Laurel Smith-Doerr. 4th ed. Cambridge, MA: The MIT Press.
- Stirling, Andy. 2006. "Precaution, Foresight and Sustainability: Reflection and Reflexivity in the Governance of Science and Technology." In *Reflexive Governance for Sustainable Development*. Edward Elgar Publishing. <https://china.elgaronline.com/display/9781845425821.00020.xml>.
- Struhkamp, Rita M. 2005. "Patient Autonomy: A View from the Kitchen." *Medicine, Health Care and Philosophy* 8 (1): 105–114. <https://doi.org/10.1007/s11019-004-1134-2>
- Sudnow, David. 1967. *Passing On. The Social Organization of Dying*. Englewood Cliffs: Prentice-Hall.
- Szyf, Moshe. 2009. "Epigenetics, DNA Methylation, and Chromatin Modifying Drugs." *Annual Review of Pharmacology and Toxicology* 49 (1): 243–263. <https://doi.org/10.1146/annurev-pharmtox-061008-103102>.
- Timmermans, Stefan. 1999. *Sudden Death and the Myth of CPR*. Philadelphia: Temple University Press.
- Verran, Helen. 2001. *Science and an African Logic*. University of Chicago Press.
- Von Schomberg, René. 2011. "Prospects for Technology Assessment in a Framework of Responsible Research and Innovation." In *Technikfolgenabschätzen lehren: Bildungspotenziale transdisziplinärer Methoden*, edited by M. Dusseldorp and R. Beecroft. Wiesbaden: VSVerlag.
- Von Schomberg, René. 2013. "A Vision of Responsible Innovation." In *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*, edited by Richard Owen, Maggy Heintz, and John R. Bessant, 51–71. Chichester: John Wiley & Sons.
- Wahlberg, Ayo, and Nicolas Rose. 2015. "The Governmentalization of Living: Calculating Global Health." *Economy and Society* 44 (1): 60–90. <https://doi.org/10.1080/03085147.2014.983830>
- Winner, Langdon. 1980. "Do Artifacts Have Politics?" *Daedalus* 109 (1): 121–136.