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ABSTRACT

From the early days of Responsible Research and Innovation (RRI), luck has played the role of an antagonist to responsibility: responsible innovation is, in part, an effort to control for the possible negative effects of luck – the chance that chance itself will take our technologies in directions that we would rather avoid. If we are to have innovations that are socially desirable and ethically acceptable, it seems, we must prevent bad luck by controlling for uncertainty wherever we can. This control-based approach has, however, proven to be impossible, with consequences for the practice of research, for the institutions that fund and guide research directions, and for how we as a society conceive of the potential for responsible research to deal well with the uncertainties of our contemporary and future world. This special issue of the *Journal of Responsible Innovation* tackles the relationship between responsibility and luck head on, with authors providing assessments and potential solutions for the problems that luck creates, for how researchers conceive of their own responsibilities, how institutions can be more responsible toward research itself, and how we can take luck up into our innovation practices in a productive way.

KEYWORDS

Luck; Serendipity; Responsibility; Governance; Responsible Research and Innovation

Luck and responsible innovation

Before addressing the diverse and intriguing viewpoints introduced and proposed by the contributors to this special issue, we will survey the problem of luck in the field of Responsible Research and Innovation (RRI) to illuminate the importance of the present project and our enthusiasm for it. While the relation between luck and RRI is straight-forward on the surface, it presents itself as opaque and complex once one starts looking underneath (Sauder 2020). The special issue proceeds from the premise that it is indeed possible to read RRI as an attempt to contain and constrain the influence of luck in science and innovation, to prevent technological catastrophe and to ensure that those endeavours are responsive to social values. On this reading, the very motivation for RRI implies that luck is a threat to the responsible governance of science and technology.

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In recent philosophical literature, luck has been considered so elusive that philosophers have even called it a myth – it is a concept that we can neither get a hold of nor form a consistent idea about. In his excellent and popular *The Myth of Luck*, Hales declares confidently that '"luck" has proven to be a crudely thrown-together junk drawer of vaguely connected ideas, none of which lives up to its billing alone or in tandem' (Hales 2020, 194 f.). In short, 'Luck is a cognitive illusion' (Hales 2020, 194 f.) Of course, luck is not the first concept that – upon thorough philosophical investigation – has been declared to be an illusion and targeted for discard, cluttering our vocabulary: Free will (Smilansky 2000), consciousness (Dennett 1990) and morality (Mackie 1990), have all similarly been declared illusory, since each allegedly lacks a referent. Philosophical work has progressed since those declarations, however, and like those other concepts, luck too might be not only something we can yet get a hold of, but something that generates valuable discussion and debate.

It is likely that we will never be able to establish a theory of luck that entails a single condition that all examples of luck fulfil – examples of luck might share only a family resemblance, like games: Wittgenstein famously failed to find one condition that all games fulfil, analogous to our conceptual problems with luck. Whatever the difficulties in pinpointing exactly what luck refers to, and thus in establishing a consistent theory of luck, it is clear that the concept fulfils important explanatory functions in our everyday lives.[1]

Consider someone who walks down the street and gets hit by a falling roof tile: How much bad luck this person has had! Utilizing the concept of luck in such contexts conveys diverse information. It suggests that something significant (in this case something extremely negative) has happened to this person, which was both very unlikely and totally unexpected. Because it was unexpected, the event could not have been controlled by the affected person.[2] If that person had known what would happen, she would likely have taken a different route that day. In such situations, we naturally search for someone to hold accountable, but finding out that luck was involved tends to dissolve the need and, importantly, the motivation to look any further for such accountability. No one dropped the tile or pushed her under it – luck led to the coincidence of those events, or so we assume. That is, this event meets all the standard conditions usually associated with luck: The event occurred unexpectedly, it was beyond her control, it was very unlikely and it had significant consequences. Since the consequences were extremely negative, we consider this a typical instance of *bad* luck. Usually, more than one of these four conditions are met, when luck occurs, but hardly ever all of them. Some events are beyond control and significant – like being rejected for a position (something that can also be very likely, if there was a large number of competitors). Other events are unlikely and significant, but more or less under one's control, like winning the French Open – at least, that's what Roger Federer would claim. Thus, both are cases of luck that have what Wittgenstein called a family resemblance.

In general, events that are significant, unexpected and beyond control are *troublesome*. This is particularly true in relation to science and technology, where much is at stake. As innovation processes are complex, dynamic, many-hands-endeavours, it is generally recognized that no one individual or actor has control over this process and that it is difficult if not impossible to accurately predict (Sand 2018; von Schomberg 2013). Thus, the RRI literature unsurprisingly acknowledges luck's existence early on and

with an immediate expression of discontent over its power: In one of RRI's defining articles, Stilgoe et al. suggest that 'unforeseen impacts – potentially harmful, potentially transformative – will be not just possible but probable' (Stilgoe, Owen, and Macnaghten 2013). What seems most troublesome to the authors here – aside from the assumed probability of unexpected and unforeseen things to happen – is the potential that an unforeseen event can have a tremendous *negative impact* on society.

Clearly, lucky events are significant, but in which way they are significant cannot be known in advance. Luck itself is ambivalent. It entails the possibility of bad luck *and* good luck. Importantly, not all luck is *bad* luck: The person from the previous example might have been unexpectedly hit by a (not too heavy) sack of dollar bills: How much *good* luck can one have! Since she could not have known which one it would be (she also could not have known that anything would hit her in the first place), she could not have prepared specifically for it. Thus, the question, 'Should she have worn a helmet, or carried a bag to collect the cash?' seems meaningless until after the event. It is hard to imagine anyone posing this question before the event happened; indeed, asking such a question would have led to doubts about how much luck was really involved. And yet, by focusing on the possible *negative impacts* of unforeseen events in science and innovation in the exposition of their framework, Stilgoe et. al. highlight stark concerns with luck's involvement in these processes. Being unforeseeable and uncontrollable – key conditions in many conceptions of luck – also comprise the two horns of the Collingridge Dilemma, another motivator behind RRI frameworks and visions (Genus and Stirling 2018). Collingridge suggested that the real consequences of technology remain unforeseeable until those technologies are widely distributed and implemented in society. By the time we know enough about them, the technologies have become so deeply entrenched in society that we have lost the power to control their effects (Collingridge 1979, 1980).

In another founding article, prominent RRI scholars acknowledge that, 'science and innovation have time and again been shown to simultaneously co-produce often unintended and unforeseen impacts' (Owen et al. 2013). The authors then list a number of technological catastrophes and disasters – instances of bad luck, in other words – which RRI (through its commitment to the dimensions of anticipation, responsiveness, reflection and deliberation) aims at mitigating if not preventing in the future (Owen et al. 2013, 31). René von Schomberg is more explicit, stating that the goal of responsible innovation is establishing innovations that have the 'right impacts' and are 'socially desirable' (von Schomberg 2013). He suggests right away that due to a lack of predictability and lack of control (of individual agents), ensuring those outcomes is problematic, to say the least: 'Modern innovations […] hardly ever have a single "author" who can be held responsible for their use (by others). Moreover, the negative consequences are often neither foreseeable nor intentional' (59). Von Schomberg could have written straight-forwardly that this makes the success and eventual social desirability of innovation a matter of *luck*.

None of the most ardent proponents of RRI intend to accept this status quo, however: 'Allowing the future to take care of itself in the face of uncertainty is neither a satisfactory, or acceptable approach' (Owen et al. 2013, 34). Rather, it is fair to say in sum that RRI can be understood as an attempt to contain and constrain the influence of luck on the governance of science and technology. This understanding aims at developing products and

processes that align with social values and are ethically desirable. RRI thus attempts the seemingly paradoxical: the control of something that is by definition beyond control.[3] A similar stance is encouraged by business gurus such as Clayton Christensen, who recommends that we 'compete against luck' to ensure success instead of relying on luck (as one's market competitors will allegedly do)(Christensen 2016). In conclusion, we have found an attitude of renunciation of luck in the RRI literature that seems to derive primarily from a focus on the negative consequences of luck, the unforeseen disasters and technological catastrophes.

But recall that luck is ambivalent regarding its value: Lucky events are significant, but neither always good nor always bad. In some instances, one person's bad luck might be someone else's good luck, or *vice versa* (Rescher 1995, 23). Hence, do we not also undermine the possibility of making meaningful unforeseen and unintended *progress* if we try to contain and constrain luck of all sorts?

Researchers who work on various aspects of serendipity and how it emerges in science and elsewhere have recently drawn attention to the possibility of fostering the positive impacts of unsought knowledge and insights. A classical definition of serendipity suggests that serendipitous discoveries are discoveries that have not been sought (Andel 1994; Merton 2004). Other definitions suggest that it means 'looking for one thing and finding another' (Gillies 2015, 526). There are numerous examples of this phenomenon. Royston Roberts collected a number of historical examples, illustrating similarities and common patterns among them (Roberts 1989). Other theorists have suggested ways we could reproduce and utilize certain conditions that contribute to valuable discoveries and technological progress so as to 'cultivate serendipity' in science and in our lives (examples include Copeland 2017; Kantorovich and Ne'eman 1989; Sauer and Bonelli 2020; Yaqub 2018). A paradigmatic case in the serendipity literature is the discovery of Penicillin by Alexander Fleming (Copeland 2018; Sand 2019). But even in respect to Fleming and that well-trod narrative from history, not everyone agrees with its paradigmatic status. Fleming had, in fact, 'always [been] on the lookout for new bacterial inhibitors' (Gillies 2015) – though he was clearly not searching for such an agent at the time and in the place he observed it, in the famously almost-discarded petri dish, having just returned from vacation. It is also clear that not all accidental discoveries are lucky, although they all involve some unforeseen and, thus, uncontrolled events (Arfini, Bertolotti, and Magnani 2018): When I find a pair of old, dusty gloves fit for the garbage while searching for my keys, I find something I haven't been looking for. Yet, I am not particularly lucky if I neither gain nor lose anything of value from the event.

As stated, recent work offers recommendations on how to capitalize on serendipity to foster lucky discoveries. Many serendipitous discoveries have brought about progress and societal value; Antibiotics, X-Rays and similar discoveries greatly contributed to well-being and longevity in modern societies, and so there are good reasons to promote serendipity in scientific practice, the argument goes. Gillies, for instance, presses researchers to 'always keep an eye open for something unexpected, and reflect as to whether this unexpected occurrence might have some significance' (Gillies 2015). In terms of policy, he suggests that research 'and its funding should be organized so that the researcher is encouraged to adopt a flexible attitude towards his or her research plans, and to be prepared to alter those plans in the light of unexpected developments' (Gillies 2015). Gillies calls this the 'principle of encouraging flexibility' (530).[4] Of note,

in the results of their study published in this special issue, contributors Sand and Jongsma find that many scientists are indeed in favour of such a principle (Sand and Jongsma 2020). Arfini et al. write, more generally,

> that one goal of the research is to find a way to elicit serendipitous encounters, to make [them] happen more and more often, especially in scientific frameworks. More specifically, scholars are looking for a way to elicit accidental events of the right kind to spur the investigation in unpredicted ways.

As in RRI, which aims to control the seemingly uncontrollable, Arfini et. al. concede that an air of paradox surrounds their directive: 'How could we connect preparation with an unexpected experience?' (Arfini, Bertolotti, and Magnani 2018).

Thus, despite the underlying desire to control and constrain bad luck and its influence on our attempts to be more responsible in innovation, recent literature, particularly in the area of serendipity science, has taken a positive approach to luck that embraces our potential to encourage good luck. Accordingly, *What really is the value of luck? How does it impinge on different contexts of (responsible) science and innovation? Shall we foster or contain it?* These are some of the key questions that the articles in this special issue have addressed.

Responsibly dealing with luck – summary of contributions

The contributors to this special issue have tackled the problems that luck poses for responsible innovation from three perspectives, generally speaking. Grinbaum (2020), Chiapperino (2020) and Sand and Jongsma (2020) address the issue from the perspective of practicing scientists and individuals. How are we, as people, to act responsibly and at the same time acknowledge that luck may interfere with those intentions, no matter how sincere? In their own way, each of their contributions is interested in the moral import of luck and our diverse individual and collective responses to it. The second perspective is of a wider scope, as articles and commentaries by authors Roumbanis (2020), Gildenhuys (2020) and Reinhart and Schendzielorz (2020), debate different mechanisms for research funding allocation. This discussion is not only about the legitimacy of two very different funding allocation mechanisms, but also about the very nature and governance of good science. Lotteries allegedly distribute resources more fairly than the established system of peer review, by many perceived as already arbitrary and costly. The luck of the funding draw can affect the esteem of scientists and that of science itself. Accordingly, these authors ask whether we should constrain or take advantage of the nature of luck to further enhance the fairness of resource distribution in science. And finally, the third group of papers explicitly addresses the matter of luck in the context of responsible innovation – how can we be both lucky and responsible? Sauer and Bonelli (2020) and Jacko (2020) give us, in turn, observational reports and theoretical insights toward how to integrate a more positive notion of luck as an opportunity for serendipity into our approaches to innovation.

From the perspective of individuals, luck can have an effect on our ability to act responsibly: If we acknowledge that our efforts might be thwarted by luck, then the resulting uncertainty about which actions are most likely to be responsible in the end, factoring luck in, can result in an inability to act with conviction or even at all.

Further, the potential influence of luck affects our ability as a society to assign responsibility to individuals for their actions; we tend to avoid making people responsible for things outside their control, and if the results of one's actions are, theoretically, always beyond their control, thanks to luck, then responsibility frameworks seem impossible to establish fairly. In respect to the ability of the scientist to act at all, Grinbaum (2020) calls attention to the importance of self-trust and confidence in the practice of science. If scientists are filled with doubt, they hesitate to innovate, seeing it as a risk rather than an opportunity. His proposed resolution is the adoption of wholeheartedness, rather than consequences, as the standard by which we should judge the responsibility of individual actions: So long as scientists commit to being as thorough in their assessments as they can, they can act with wholeheartedness and pursue opportunities for innovation with confidence.

Chiapperino (2020) addresses the problem from a different angle, asking what we can expect from individuals in terms of acting responsibly, when deep uncertainty is an inherent feature of the situation to which we are asking them to respond. The situation this article examines is created by our recently expanded knowledge about the epigenome: Given this newly acquired scientific knowledge, ought we expand the responsibilities of individuals to take additional precautions – to change their behaviour – in light of that new knowledge? In short, does this scientific innovation also amount to new responsibilities for individuals? Chiapperino questions the rationality of new expectations for changing behaviour since, due to the role of luck in relation to our epigenome itself, the very same behaviour may lead to either a good or a bad outcome. The problem presented to us by epigenetics, then, bears a strong resemblance to the philosophical problem of moral luck; whether or not our behaviour is responsible is determined by its outcome (which in turn is itself, often, seemingly determined by luck), rather than by our 'a priori good or bad deeds' (Chiapperino 2020) . The article paints a complex relationship between our increasing capability to trace out causal relationships as we make scientific progress, and the inherent unpredictability that comes with the correlating increasing complexity of the systems in which our actions, and their consequences, take place, resulting in a responsibility dilemma.

How do scientists deal with this dilemma? Grinbaum proposes a new standard by which they can confidently judge the responsibility of their actions, redirecting our attention away from unpredictable outcomes and toward intentions we can control. Chiapperino suggests that we take up that unpredictability into our responsibility models and address the resulting dilemma head on, making room for uncertainty when we debate where to assign blame by taking the question of responsibility up into the community level to assess collaborative, rather than individual, actions. Chiapperino, however, is clear that on the collective level (moral) luck is no less of a problem: collectives' composition is of greatest importance for their effectiveness, but this is often dependent on the histories of the constituting individuals and the circumstances surrounding their getting together.

Sand and Jongsma, in turn, ask individual scientists how they perceive and respond to the problem of luck in relation to responsibility within their own practice, as well as in their views of science and its institutions. Do they experience luck and, if so, how threatening is its existence? They find that, in general, luck is seen as something to manage through the practice of science itself: experimental design, skilful analysis and educated

hypothesis-building are meant to remove the influence of luck over one's results. In short, the practice of good science is itself the opposite of being lucky. But this is not to say that luck should be taken out of the practice of science. Rather, essential aspects of both personal success in science and scientific progress depend on factors one cannot, and perhaps even should not, control – opportunities for innovation and discovery come out of the networks, social connections, funding and career opportunities that often arise by chance, as experienced by the scientists Sand and Jongsma interview.

The relationship between individual experiences with luck and the role of luck in the practice of science more generally has implications for the institutions of science: in particular, it has grounded recent arguments both in favour of and against changing peer review approaches to funding research over to lotteries. This special issue thus pairs two research articles with a perspective article to draw out the insights this debate has with respect to what responsible scientific institutions should look like, when we take account of luck.

Gildenhuys opens the debate as presented here by calling attention to this difference in perspectives directly. Lotteries may be unfair from the perspective of the individual scientist, but they ultimately make the practice of science – as an enterprise in which many individuals take part and in which society has a vested interest – fairer. As the author puts it, we 'stomach the unfairness' as individuals, for the sake of another value, the fairness of science overall. In contrast to this position, Reinhart and Schendzielorz argue that lotteries do not help to make science more fair than current practices of peer review. The fairness that peer review establishes is about much more than equitable funding allocations, argue these authors – meritocracy is the foundational ideal of organized skepticism and substantive justice in science, the loss of which cannot be made up for by prioritizing procedural justice through a lottery. Indeed, lotteries seem defeatist in the face of luck, in light of these points. Both articles accept that peer review is unfair; where they differ is on whether lotteries – funding at least in part by chance – would be fairer. Can luck be made fair, despite its inherent unfairness? Reinhart and Schendzielorz argue it cannot; Gildenhuys argues that it is a matter of perspective.

In a final perspective article on this debate, Roumbanis argues directly against defenses of peer review such as those proposed by Reinhart and Schendzielorz. The belief that peer review is fairer than lotteries is wrong on two counts, each grounded in what is now, argues Roumbanis, more dogma than reasoning. It does not make science fairer, and neither is it fair for individuals. He draws our attention in particular to those scientists whose research would have produced great success for themselves and for science, except that, through bad luck, it had not been funded. In the end, the arguments about what peer review and lotteries *should* be able to do, in respect to making science more fair (and scientific institutions more responsible in how they award individuals) in the face of ineliminable luck, is not what should be at issue: Roumbanis calls for empirical research into the matter of whether lotteries are *actually* more fair than peer review.

Sauer's and Bonelli's contribution provides a salve for those who worry that luck can only have negative implications for their success, with a positive account of luck's potential in serendipity. Their account resonates with dimensions in the contributions by Sand and Jongsma and by Chiapperino in their emphasis on the collective nature of innovation

and their interpretation of improvization as a skill. They analyze the case of *Trasformatorio*, a site-specific performance research lab, and they point out the benefits of framing social innovation processes as forms of collective improvization in the conclusions of their paper. Their perspective encourages thinking about 'how the step can be made between ungovernable serendipity and governed improvization in responsible innovation processes.' The intent behind their suggestion is clear: by choosing the right innovation environments (e.g. living laboratories) that foster improvization amongst diverse people with distinct situated knowledge, one can facilitate unexpected insights and thus achieve more serendipity. This strongly resonates with observations outlined above: serendipity scholars are eager to see luck as not only a threat but as an ally, responded to as a drummer responds to a solo of the saxophonist. This way of seeing has a clear positive connotation to luck that contrasts with the noted tendency among RRI proponents to emphasize its negative aspects.

Jacko (2020), in his contribution, reminds us of an important point from the RRI literature: Even if the procedural conditions of innovation are highly sensitive to all sorts of ethical problems, the success of innovation is never guaranteed. Luck is a necessary condition for successful innovation, Jacko claims. But how would we determine in the first place what it means from a moral perspective for an innovation to be successful? This is a normative question *par excellence*, and one that would be answered very differently by theorists of different ethical schools. Nevertheless, this is an issue of greatest importance: Must we not first have a clear normative vision of a successful innovation before we can then start constraining luck as it suits this goal? With this in mind, Jacko encourages us to think about both the process and product dimensions of RRI, before making any hasty decisions about how we ought to deal with luck.

Conclusions

The contributions to this *Journal of Responsible Innovation* special issue share a fascination for the topic of luck, its power to change the course of science and technology, and its conceptual elusiveness. Individually and as a whole, the papers provide depth to our understanding of the relation between luck and the responsible governance of science and technology, and they lead us to reconsider whether luck should be primarily seen as challenge or chance for those fields. Overall, the collection invites us to see how luck can be seen not only as a threat to the responsible governance of science and technology but also as a resource for it. Indeed, the special issue and its contributors can be seen to represent a growing, anti-stoicist impetus in the face of luck and responsibility. The Stoics recommended that we give up caring about what is beyond our control. Hales puts Stoic philosophy in a nutshell:

> [S]top desiring what is not within your control. Our bodies, our possessions, our reputations, and social status are all subject to ill luck, but we are harmed when we lose our assets or our status only when we misjudge the value of those things. (Hales 2020, 13)

In stark contrast, the special issue as a whole helps to develop the philosophical basis underlying the desire to improve innovations and to steer them towards social desirability. As Grinbaum argues, for instance, one should attempt this wholeheartedly rather than not at all. While luck might interfere with achieving certain values, we should

nevertheless not lose sight of or stop caring for them.[5] This special issue can thus be understood as an effort, among others, to increase our understanding of luck, to engage with it responsibly, and to trace the threads of its relation to science and technology in order to *make the most of our luck*.

Notes

1. Something that many error theorists of morality and error theorists of free will and consciousness also admit.
2. Note, that the reverse does not always hold – there are events that cannot be controlled, but are expectable.
3. Seemingly sceptic about the prospect of such endeavour Grinbaum and Groves assert that '[…] no matter how carefully and responsibly one innovates 'there is no guarantee that moral luck in the uncertain future will not mean that one's efforts to act responsibly will not turn out to have unintended consequences' (Grinbaum and Groves 2013, 139).
4. The *JRI* editor-in-chief notes that Gillies' principle hearkens back to Stokes' (1997) seminal science policy concept of 'use-inspired basic research,' an idea that is surprisingly absent from scholarly discussions of responsible innovation, although it does feature prominently in the organizational design of institutions that seek to practice responsible innovation such as Arizona State University (Crow and Dabars 2020).
5. As Martha Nussbaum has noted, neither have the Stoics been consistent in this pursuit (Nussbaum 2019).

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