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# Scientists' views on (moral) luck

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**ABSTRACT**

Scientific discoveries are often to some degree influenced by luck. Whether luck's influence is at odds with common-sense intuitions about responsibility, is the central concern of the philosophical debate about moral luck. Do scientists acknowledge that luck plays a role in their work and – if so – do they consider it morally problematic? The present article discusses the results of four focus groups with scientists, who were asked about their views on luck in their fields and its moral implications. The participants underscored circumstantial luck as a key dimension of luck in science. Nevertheless, most participants insisted that there are ways of executing 'control' in science: They believe that virtues and skills can increase one's chances for success. The cultivation of these skills and virtues was considered a reasonable ground for pride. Prizes and rewards were rarely tied to personal desert, but instead to their societal function.

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Moral luck; serendipity; qualitative research; control; RRI

## Introduction

A growing body of literature suggests that luck is an important factor in the scientific process: Luck plays a role in the socio-political environment that establishes funding opportunities, enables the scientific system and allows for the unhindered exchange of ideas (Trout 2016, 2019), but also in terms of individual encounters with chance that make people stumble upon unexpected findings or have lightbulb moments, which they did not anticipate.[1] In current discussions in Science and Technology Studies (STS) and philosophy of technology, luck is both seen as a threat and as a remedy for scientific endeavours. It is seen as a remedy to challenge bias and to make research funding allocation more efficient by utilizing lotteries in this process (Roumbanis 2019; Adam 2019). It is seen as a challenge, on the other hand, since it strongly affects whether scientists make important discoveries or produce technological innovations, which ultimately determines whether and how their careers flourish and whether they receive prizes or grants for their work. This is considered morally dubious. In moral philosophy, this problem related to the attribution of responsibility in terms of praise, blame and reward, for events beyond one's control, is known as the problem of moral luck. This problem seems to be prevalent in

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science, too: Scientific achievements partially escape scientists' control and yet have an impact on whether they are praised and rewarded and – if so – to which degree. This causes a misalignment between desert and credit, which is increasingly seen as morally problematic (Sand 2020).[2]

While there is a lack of consensus about the value of luck in science (Is it rather a challenge or a chance?), it is regarded as particularly troublesome that a process ideally guided purely by reason is vulnerable to chance:

> Under an ideology that equates science with prediction and control, the role of luck or fortune seems incompatible with great discovery. We desire to find something out and, having gathered and evaluated the evidence, we have the feeling that the evidence is now under our cognitive control – that we understand. (Trout 2016, 121)

Many proponents of Responsible Research and Innovation (RRI) – a field in which moral luck has also caused unsettledness and concern, as we will describe in more detail in the next section – suggest that governing science and innovation responsibly should not solely rely on expert knowledge or top-down decisions by policy-makers (Owen et al. 2013, 38), but should include those stakeholders that are affected by such decisions to open up the governance of those fields. This applies equally to the ways of responding to luck. Whether it is attempted to 'control' luck by establishing future-oriented policies to become more responsive and caring (Adam and Groves 2011; Grinbaum and Groves 2013), or whether it is intended to utilize luck by employing lotteries for research funding allocation, it is important that those measures are aligned with the views of the people, who are affected by them; scientists and innovators. This underscores the importance of the present empirical study into (moral) luck in science and researchers' views on it. Previous empirical studies on moral luck have predominantly focused on a particular type of luck; resultant luck (luck in how things turn out) (Lench et al. 2015; Cushman 2008). The results of these studies are inconsistent: Some of them suggest that resultant moral luck does exists that people decide whether a person should be blamed or punished dependent on her intentions **and** the consequences of her actions (Cushman 2008), others conclude that resultant moral luck does not exist (Kneer and Machery 2019). It is not clear, whether this inconsistency can eventually be resolved and whether and how the intuitions of the participants of such empirical studies can have a bearing on the problem of moral luck. It is obvious, however, that previous empirical studies have predominantly focused on resultant moral luck by drawing on examples from everyday life and the context of law.[3] But, how is the involvement of luck **in science** perceived beyond the category of resultant moral luck?

Our study responds to this question by focussing on the context of science and utilizing a qualitative method to explore the notion of luck in a more open fashion without precluding other types of luck beforehand. We provide a comprehensive picture of how scientists perceive the involvement of luck in their work, whether and in which ways this affects their beliefs and sentiments related to responsibility and how they evaluate these facts. In the present article, we present our findings and analyse them on the backdrop of existing literature on moral luck, serendipity and RRI. In the following sections, we will first describe in more detail the theoretical background of our paper (2), our qualitative research method (3), present the most significant results of this study (4), discuss these findings

and their scope (5) and draw some conclusions for the debate about moral luck in science and the responsible governance of science and technology (6).

## Theoretical background

Moral luck is widely perceived as a philosophical problem. This problem regained attention after two papers written by Bernard Williams and Thomas Nagel in the 1970s (reprinted in Nagel 1991; Williams 1981).[4] The moral luck problem can be characterized as follows: Responsibility is appropriately attributed only to things within people's control. People are usually not responsible for other people's wrongdoings because these are beyond their control. But, if it is true that people are in fact admired, praised, rewarded and punished for things they did not control, then this is at odds with the previous claim that responsibility ought to be luck-free. A famous example that illustrates this paradox, has been discussed by both Williams and Nagel: A drunken driver who crashes into someone, will receive very different responses in terms of punishment and blame than a drunken driver, who does not crash into someone. But whether that happens depends on factors beyond their control, e.g. whether someone passes the street. Nagel writes that the drunken driver, who is lucky to not hit anybody, would 'be reproached by others much less severely' (Nagel 1991, 29). He claims that the emerging paradox is a 'natural consequence of the ordinary idea of moral assessment, when it is applied in view of a more complete and precise account of the facts' (Nagel 1991, 27). Moral philosophers could argue that people **should** not reproach the unlucky driver more than the lucky one. But Nagel's account also raises the (empirical) question, whether people in fact judge the unlucky drunken driver to be **more responsible** and whether they would actually reproach her more. Recent empirical studies suggest that a majority of people do in fact **not** evaluate the two drivers morally different (Kneer and Machery 2019). The drunken driver case exemplifies resultant luck (luck in how things turn out). However, the moral luck debate acknowledges three other types of luck: (a) causal luck, which is the problem of determinism, (b) constitutive luck, which refers to the character and temperament one is born with, (c) and circumstantial luck, which refers the opportunities one faces in life.

Studying the role of (moral) luck in science and innovation is important as much of the existing literature is focused on legal or everyday life examples similar to the drunken driver case. As argued before, these are not the only areas, where luck strikes: It is widely acknowledged that it is often a matter of luck, whether research leads to significant findings (Martin 2007, 52; Rescher 1995, 91 f.). Even more troublesome, significant findings in terms of successful publications or other (more material) innovations that demonstrably display the fruition of research are much more praised than candid but ultimately unsuccessful research endeavours. Consider Alexander Fleming, who stumbled by accident over a Penicillin producing strain of mould. His research went unnoticed for a dozen of years until others utilized it to bring about the antibiotic revolution of the second half of the twentieth century (Copeland 2018). Without this chance encounter and the support of others, Fleming's work would not have had the same impact and likely not been rewarded with the Nobel Prize (Sand 2020). One might argue that the described case does not – in contrast to the drunken driver case – constitute a moral problem *sui generis*: It is not Fleming's **moral** worth that is at stake here, but his **scientific**

worth (Sand 2020, 900). It might be better, thus, to call this the 'alleged problem of scientific luck' and add that scientific luck is actually unproblematic. However, the latter is far from obvious and does not follow naturally. Fairness is an underlying concern of the moral luck problem: Whenever people do not get what they deserve due to factors beyond their control, intuitions about fairness naturally resurface (Zimmerman 2015). However, the present study is an empirical one, which starts out by complying as much as possible to a methodological 'veil of ignorance,' that includes considering that there is something like a problem of scientific luck beforehand. For the present purposes, we do not endorse any particular view on moral luck including those described in the following.

In the RRI literature, luck's involvement in science and innovation is primarily seen as a challenge for the responsible governance of science and innovation. For example, Stilgoe, Owen and Macnaghten write that moral luck appeals 'to unpredictability and an inability to "reasonably foresee", [which] will allow us to escape moral accountability for our actions.' They express their dissatisfaction with this notion of moral luck and suggest instead to focus on 'future-oriented dimensions of responsibility – care and responsiveness – that offer greater potential to accommodate uncertainty and allow reflection on purposes and values' (Stilgoe, Owen, and Macnaghten 2013, 1569). However, even if we agree that care and responsiveness can mitigate the risks involved in science and innovation, it remains doubtful that promoting those dimensions can bring about certainty. As long as there remains uncertainty – even if well accommodated – there also remains the potential for luck's interference. Alexei Grinbaum and Chris Groves write in this manner 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). Ever since this exchange on the relation between moral luck and RRI, the problem smoulders beneath the RRI discussion. Taken together, this underscores the importance of studying how scientists perceive the involvement of luck in their work, which conclusions they draw from this and how one might responsibly deal with luck in science the future.

## Method

### *Research design*

For this study, we chose a qualitative method, because both 'luck' and 'responsibility' are multifaceted concepts. Responsibility includes judgments of blame – and praiseworthiness or overt responses to those judgments in terms of blame or punishment, or praise and reward. Responsibility also entails the dimension of the moral sentiments that often accompany such judgments and responses. We were, therefore, also interested to learn about scientists' emotions regarding their work in relation to luck; whether they felt proud of their achievements or regretted certain decisions, if those were affected by luck. This is a central dimension of the moral luck debate that has not yet been empirically studied (Wolf 2001; Williams 1981). Furthermore, we did not focus on a specific type of luck as previously done with regard to resultant luck (Kneer and Machery 2019; Lench et al. 2015) but wanted to understand how scientists perceive and understand luck more broadly, including causal, constitutive and circumstantial luck.

To gain insights into the beliefs and convictions of scientists, four focus groups were undertaken and thematically analysed (Dierckx de Casterlé, Chris Gastmans, and Denier 2012; Green and Thorogood 2018). Focus groups are a well-suited method to investigate how researchers understand and make sense of their own experiences, beliefs and convictions. The study followed the Consolidated Criteria for Reporting Qualitative Research (COREQ) Guidelines (Tong, Sainsbury, and Craig 2007).

## Participants

Participants were considered eligible for participation if they had experience with working in science (i.e. academic work experience after obtaining a master degree in science or engineering). To capture a wide range of perspectives, a variety of participants from different professional backgrounds and level of seniority (see Table 1) were selected. Participants both from more experimental and more theoretical fields of science were included. Research group leaders from within our network were approached and asked to forward an invitation to other scientists in their groups. Individual participants, who were interested to participate, were approached by email with further information. Recruitment was ended when saturation was reached, e.g. when subsequent data collection no longer brought up new issues ('coding saturation') and the formulated themes were sufficiency understood ('meaning saturation') (Hennink, Kaiser, and Marconi 2017).

## Data collection

In the summer and fall of 2019, four focus groups with in total 17 participants were conducted. Each focus group lasted approximately 1.5 hours and was carried out in a private room at the university, where the participants work. All focus groups were conducted in English. Demographic information was collected before the start of the focus group. A

**Table 1.** Demographic details of the focus group participants.

| Category | Classification | *n* (%) | FG1 (*N*=7) | FG2 (*N*=3) | FG3 (*N*=3) | FG4 (*N*=4) |
|---|---|---|---|---|---|---|
| Age | 22–30 | 8 (47) | 7 | 1 | 0 | 0 |
| | 30–50 | 8 (47) | 0 | 2 | 3 | 3 |
| | >50 | 1 (6) | 0 | 0 | 0 | 1 |
| Gender | Male | 15 (88) | 7 | 2 | 3 | 3 |
| | Female | 2 (12) | 0 | 1 | 0 | 1 |
| Graduate degree | Engineering sciences | 7 (41) | 7 | 0 | 0 | 0 |
| | Natural sciences | 10 (59) | 0 | 3 | 3 | 4 |
| | Other | 1 (6) | 0 | 0 | 1 | 0 |
| Work experience (years) | 0–2 | 7 (41) | 5 | 2 | 0 | 0 |
| | 3–5 | 5 (29) | 2 | 1 | 2 | 0 |
| | 6–10 | 3 (21) | 0 | 0 | 1 | 2 |
| | 11–15 | 1 (6) | 0 | 0 | 0 | 1 |
| | >15 | 1 (6) | 0 | 0 | 0 | 1 |
| Experience with publishing | Yes | 16 (94) | 6 | 3 | 3 | 4 |
| | No | 1 (6) | 1 | 0 | 0 | 0 |
| Ever won a prize/grant/funding (multiple answers) | Yes | 13 (76) | 5 | 2 | 2 | 4 |
| | No | 3 (21) | 2 | 1 | 0 | 0 |
| | Applied unsuccessfully | 2 (12) | 0 | 0 | 1 | 1 |

topic list consisting of open-ended questions was used to guide the focus groups. This topic list, based on literature and expert knowledge of the research team, covered four main topics: (1) (experiences with) luck in science, (2) significance of control (3) responsibility and moral sentiments (pride and shame) in relation to luck (4) dealing with rewards and luck in science (policy and governance). All focus groups were moderated by Karin Jongsma (background in qualitative research methods) and observed by Martin Sand (Principle Investigator of the project). The authors ensured that all predefined topics were discussed and made field notes during the focus groups. The moderator and observer knew a few of the participants before the start of the focus group. All focus groups were recorded and transcribed verbatim. Informed consent for participation in the focus groups, for recording of the focus groups and for data analysis of pseudonymized transcripts was obtained from all participants. The Human Research Ethics Committee at TU Delft approved this study (ID: 629, approved on 22.02.2019).

### *Data analysis*

The pseudonymized transcripts were analysed thematically (Dierckx de Casterlé, Chris Gastmans, and Denier 2012). Initial codes were developed based on the topic list and familiarization with the data and were discussed in the research team. Additional codes were added and adapted in the course of the analysis. All transcripts were coded using the software Nvivo 12. The interpretations and suitability of the codes were discussed and compared amongst the research team. The meaning of individual text fragments was determined by interpreting them in the context of the whole interview with the participant in question. The process of analysis and (re-)labelling of codes resulted in the formulation of interpretative higher order themes. Throughout the process of analysis, the research team went back and forth between the different steps to guarantee constant comparison.

## Results

Below, we discuss the findings of the four focus groups structured along the following overarching themes: Luck, control, responsibility and science policy (Tables 2–5). While most participants were not familiar with the method of focus groups, they were all very open and debated enthusiastically. Several participants spontaneously brought up anecdotes, counterfactual examples and raised critical questions. In the following discussion, we indicate the scientific background or work experience of particular participants only if it helps to contextualize the expressions in comparison to other participants.

### *Luck*

Almost everyone underscored that they have encountered luck in their work. Most participants did not directly encounter luck in relation to their scientific work, but in other matters broadly related to the 'social dimension of science.' This included who has been their supervisor, whether they met interesting people from whom they could learn, whether they were present during an inspiring talk or managed to get a position, published in a high impact journal or received research funding. It was underscored by one person that there is a difference between the role of luck in scientific work and the social

**Table 2.** Quotes illustrating respondents views on luck.

| Key Theme | Sub Themes | | Illustrative Quote |
|---|---|---|---|
| Luck | Circumstantial luck | (a) Meeting the right people | 'There's luck in the sense meeting the right people. The right people teach you the right things, motivate you at the right time to do the right way. I experienced this with respect to a PhD supervisor.' (Fg3Sp2) |
| | | | 'Once I was listening to a talk from a seminar speaker here who was visiting, he was a theorist talking about computer simulations. I thought I could to with my system an experiment which would be equivalent of that computer simulation. […] I thought we can try and do the experiment and we saw something nice, interesting.' (Fg3Sp3) |
| | | (a) Working on a topic that is trending | 'In science, it's easier to get funding normally when you've got one of these topics that are hot at the moment. In that sense, the interest in the moment in your topic matters. It can be considered luck because sometimes you start a topic and you have no idea it's going to be so hot and important in two years.' (Fg2Sp2) |
| | | | 'I immediately thought of these big discoveries are pure luck but I always ask myself: Is this representative of the actual science or is it just the ones that make it to the media?' (Fg2Sp4) |
| | | (a) Reward and funding opportunities | 'I recently got this award from a previous university but they only introduced the award this year because the institute has got very good candidates and they put them up for the big PhD prize at the university but never did anyone every get the prize from molecular biology way of training, so this year they said […], we will make our own also and then I was luckily one who actually had done a lot different things, had a fairly good publication record and stuff so I get this award.' (Fg2Sp3) |
| | | (a) Socio-economic conditions – early educational opportunities | 'I feel if I look back at my life it's been a charmed life because I've been lucky in every phase, you know, from my gaining a scholarship to my undergrad degree and then finding a very good PhD mentor to finding this position here. It's been a series of really fortunate events.' (Fg4Sp3) |
| | Resultant luck | | 'In case of my MA thesis, I was testing a new measurement method. I was lucky it worked out well, and, therefore, I could continue to do a PhD. It could have happened that the method could have failed. Even though I would have worked as hard.' (Fg1Sp3) |
| Serendipity | | | 'You spend one day on a problem and have no idea how to figure it out. Suddenly, over summer, you know how to figure it out. Then, I think I am so lucky I figured this out, for instance, while having a shower.' (Fg1Sp5) |

dimension of science. This participant argued that luck plays a role in the career path, for example, for finding a good position or mentor, but the role of luck was not believed to play a role in achieving scientific breakthroughs. This has been underscored by other participants, who emphasized – as we will outline in more detail below – that there is a lot of control in the actual **practice of science**, while the social dimension of science is heavily subjected to luck: A majority of participants said that scientific career paths are interwoven

**Table 3.** Quotes illustrating the perspective of respondents on control.

| Theme | Sub Themes | | Illustrative Quote |
|---|---|---|---|
| Control | Skills | (a) Proper research design and reasonable hypotheses | 'So, how much of it is luck? It's very estimated. […] It's not just doing experiments and see what works, there was a thought behind it.' (Fg4Sp4) |
| | | | '[…] You can't do a random experiment, I think. [..] There's always some kind of idea behind what you're doing.' (Fg3Sp3) |
| | | | 'The way I do science, I try to minimise the luck I need to get good data. That's what I do for a living, basically. […] I don't want to play on luck and experiment randomly and hope that something comes up because that's not going to work. Obvious, right? It's **informed**.' (Fg4Sp4) |
| | | | 'In terms of animal experiments, I've worked with monkeys throughout my career, and there I was definitely fortunate. I never had any really serious issues. Some of them you **can mitigate by doing a lot of preparation getting plans in surgery** but some of that is like rolling a dice.' (Fg4Sp3) |
| | | (a) Hard work | 'Science is 90 percent hard work and 10 percent luck and has very little to do with brains.' (Fg2Sp3) |
| | | | 'If you put more work in, the chances are higher.' (Fg1Sp3) |
| | | | 'I think if he wins prizes he has deserved it. He has discovered it by luck, but worked hard for finding it out and published about it. It's also needs work for getting a prize.' (Fg1Sp4) |
| | | (a) Experience | 'I guess especially at more junior stages of your career you may not be able to access all the factors of a potential workplace or mentor that could either facilitate your scientific progress, or get in the way of that progress, and so this is something that I think for most people can only really be mainly be built through experience. So, I think as you become more experienced … .' (Fg4Sp2) |
| | | | '[…] you have to learn the techniques and then you become better and better.' (Fg4Sp4) |
| | | (a) Collaboration and networking | '[…] my strategy is just to talk to a lot of people, to visit every single post of interest that I can try to fit into the schedule.' (Fg4Sp2) |
| | | | 'Imagine you've talked to somebody and he has this specific thing you need, and then you can say: Oh, I was lucky, but basically you've talked to thousands of people and in those thousands of people there will be somebody who will have that knowledge. Is that by luck or is it just part of the process? **You have to talk to many people.**' (Fg4Sp4) |
| | | (a) Positioning yourself and identifying trending research | 'But you also need to be able to ride on the wave. As you explained with [name colleague], and I think that's also one of his forces is, he's very enthusiastic. I can imagine he would be good at building up the wave he's also riding on.' (Fg2Sp3) |
| | | | 'I think PIs have many years of experience. I think they're able to almost smell a good opportunity. They jump into the field at the right moment when they see something emerging as a promising field they jump into it right away if they can.' (Fg2Sp2) |
| | Virtue | (a) Perseverance | 'I feel people are intrinsically motivated to achieve certain milestones and get results and success. The person who theoretically didn't get some interesting results will still continue until they reach that point.' (Fg4Sp3) |
| | | (a) Judgment | 'He stayed on the topic and got a very nice paper but he initially didn't know and maybe he could've walked away from the project. So, it was luck he was offered that project but also you have to be **smart** or **knowledgeable** to take the opportunity or not.' (Fg2Sp2) |
| | | (a) Attentiveness | |

(*Continued*)

**Table 3.** Continued.

| Theme | Sub Themes | Illustrative Quote |
|---|---|---|
| | (a) Courage | 'Yes, and I think also it's not only **sensitivity to opportunities** but your ability to pursue those opportunities.' (Fg4Sp2) |
| | | ' … everybody tried and nobody could repeat [the published experiments], but everybody kept quiet about it, because the results that were published were so clear. […] we started looking into that question and we found a completely different mechanism, which was not at all depending on gamma. […] Somebody came to me and asked me: Are other people working on this topic? I said no, it's very exciting, isn't it? He said: I would never have done that because **he didn't want to get out of the mainstream, it was too risky**. He said: If you are wrong, then your whole career is gone. Eventually, it was published in *Science*, so it was good.' (Fg4Sp4) |

**Table 4.** Quotes illustrating the perspectives of respondents on responsibility.

| Key Theme | Sub Themes | Illustrative Quote |
|---|---|---|
| Responsibility | (a) Praise | '[…] and we have to be proud of what we actually achieved then otherwise-, I'm not sure. Like, we also need the pat on the shoulder once we have done something good.' (Fg2Sp3) |
| | | '[…] because of the uncertainty involved and the high risk of failure, it's important to keep bolstering ourselves and stay emotionally resilient. So, I think it's actually advantageous to be optimistic also to reflect back on your achievements regularly and not beat yourself up too much over the failures, because if that stops you from moving on and persevering then you're not going to get anywhere.' (Fg4Sp4) |
| | (a) Pride | 'Yes. It's also that you try. That's also part of the thing. I think that you can both feel proud that you actually tried and did your best but you can also be proud, if the outcome is successful and you got something good.' (Fg2Sp3) |
| | | 'Feeling proud about something is how good you feel about it. […] If you had something to do with how it went, then you should feel proud, and if there are some other factors there, then, sure, it's okay. As long as you feel you had some agency over what happened a little bit maybe, you can feel proud about a very small thing.' (Fg3Sp3) |

with luck in particular in relation to social encounters. Most participants described situations that can be understood as 'circumstantial luck,' or – in their words – as 'being at the right place – at the right time.' This notion can be differentiated in four classes of which the first one was predominantly mentioned: (a) meeting the right people including supervisors and peers, (b) the research topic is coincidentally socially or politically trending, (c) opportunities in terms of funding and awards, and, (d) the socio-economic environment of upbringing – including early educational opportunities and access to study programmes.

Only few respondents remarked the role of luck in how experiments and scientific research turns out, which can be strictly understood as resultant luck. The respondents did not refer to incidences, examples or notions that could be understood as causal or constitutive luck.

Somehow exceeding Nagel's classification and more closely related to what is considered as a hunch or sudden flash of insight, 'an exercise of intuition, the intuitive

**Table 5.** Quotes illustrating the perspectives of respondents on science policy.

| Key Theme | Sub Themes | Illustrative Quote |
|---|---|---|
| Science Policy | (a) Prizes | 'If I could, I'd say let's abolish prizes.' (Fg3Sp4) |
| | | 'As I said, I ask myself what is the idea of the prize? Is the prize to either communicate to the outside there is something cool and new and, therefore, we just need an occasion, or is the prize to attract other people going into this direction because there is a prize so people might work harder in order to achieve something like this?' (Fg2Sp4) |
| | | 'Yes, I think it's absolutely fair. […] Most prizes are awarded based on the impact of the discovery rather than the effort that went into it. Results aren't everything, but the results do matter a lot especially for these prizes.' (Fg4Sp2) |
| | | 'But [the prize] gives the wrong message to the public […]. The message should be that this is a **group work** and that's the group in the institute but there's some bigger groups worldwide. This is much more global effort to solve this issue and we should celebrate the discovery, the vision […] and not the scientist, who did this.' (Fg4Sp5) |
| | (a) Bias | 'I have another argument why prizes in science are really bad, because it relies on friendships and connections: How do you know this is actually the discovery worth getting a prize?' (Fg3Sp4) |
| | (a) Openness and risk-taking | 'Openness helps because as we said before when you start getting knowledge about a topic, you start thinking about all the different directions you can explore, you get enough feeling which could be more successful directions. I always think in our PhD and postdoc cycle, there is a balance between how much you explore in the finite time you have to finish a project, have a result and a publication. In principle, it will be nice if we can explore indefinitely – and that is what science maybe used to be before […].' (Fg2Sp2) |
| | | 'What many people do is being very protective of their own thoughts and own data, and then those conversations don't work … […]. Some people just don't want to say anything and then basically it's a kind of interesting conversation, but to get the real value you have to be very open.' (Fg4Sp4) |
| | | 'But I think at the moment the evaluation of scientists does not encourage exploring new directions. It's just too dangerous.' (Fg4Sp4) |

recognition of possibilities […]' (Cunha, Stewart, and Sandro 2010, 321) in the literature on serendipity, few participants mentioned that they suddenly had an insight or made a new previously unconsidered connection, when they did not actually seek such insight. Without any conscious effort, they found a solution, for instance, while having a shower or having holidays, to a problem they had faced some time ago. Such serendipitous 'flash of insight' does not fit into any of Nagel's four types of luck.

## *Control*

As shown in the previous section, we encountered a strong acknowledgement of the role of luck in science particularly in matters related to the unfolding of academic careers, or, more generally, regarding the social dimension of science. Despite this acknowledgement of luck, many participants were convinced that scientists obtain control at least over large aspects of the research dimension of their work. The famous Pasteurian saying that 'luck favours only the prepared mind' was recited by one participant. We were curious about **how** exactly one can prepare and exercise control in science. Our participants suggested various ways of doing so, which can be broadly distinguished in two classes: scientific skills and scientific virtues. **Scientific skills** can be further differentiated into (a) properly designing and setting up experiments and forming hypotheses, (b) working hard, (c) gaining experience, (d) networking and collaborating, (e) positioning oneself and

identifying trending research themes. **Scientific virtues** were mentioned in terms of (a) perseverance, (b) judgment, (c) attentiveness and (d) courage.

Particularly in relation to the aspect of properly designing and setting up experiments to test reasonable and suitable hypotheses, it was suggested that science is an endeavour intended to defy luck. Doing science means, according to the participants, to effectively exercise control. For example, experiments are not set up randomly and clueless tinkering will not lead to scientific insights. Some participants explicitly rejected the possibility that random tinkering can lead to valuable findings. It was stressed that making informed decisions and employing thought-out plans are important in order to get meaningful data. In this manner, many participants emphasized that science denotes an attempt to control certain (natural or experimental) systems, guided by an informed hypothesis and a reasonable expectation of what the outcome might be. Nevertheless, participants were humble in acknowledging that they cannot ensure the outcome of the experiments, meaning that they do not perceive control to be absolute. Participants argued that good science (science more likely to yield fruitful results) requires asking the right questions, which has to be learned: There must be a meaningful research question and educated decisions about how to pursue answering it. In relation to the techniques and skills of experimenting, one participant working with animals in the laboratory emphasized that scientific skills improve with experience. Because uncertainty remains regarding the success of experiments, the explorative spirit prevails in science. Some participants suggested that engineering, in contrast, must comply with the stricter goal of complete luck eradication. The view that especially engineering is about ensuring an outcome with great (if possible absolute) certainty was expressed several times. It was mentioned, for example, that artefacts, such as bridges, must sustain. There should be no place for luck when building such artefacts. All participants mentioned that hard work is important for being a successful scientist: Sheer luck cannot bring about success. Working hard increases the chances of being lucky and for designing better experiments according to the participants. In line with the arguments brought forward about circumstantial luck, our participants mentioned that networking and collaboration are important for exercising control: Talking to the right people can help to get better positions, conduct better experiments or to gain new ideas. Lastly, it was argued that an important skill for exercising control is to recognize trends within your field and making clever use of it. Identifying and capitalizing on emerging trends was regarded as a skill that successful and more experienced researchers have often developed, and it was stressed that it is a skill that could help young researchers to become more successful.

Aside from skills, several (scientific) virtues were mentioned. Especially perseverance and judgement were often mentioned. Perseverance was described as the willingness to continue pursuing an effort or experiments until one gets a positive result. Judgment was considered important for choosing wisely, which options and research steps to pursue. Attentiveness was described as high-awareness or sensitivity to detect significant opportunities in experiments. Only one more senior researcher emphasized the role of the virtue of courage to speak up against established paradigms, arguing that one has to take risks that others are not willing to take. This participant later suggested (see below Science policy) that risk-taking should be more encouraged in research projects.

### Responsibility

Since moral luck is suggested to be a paradox that concerns the concept of responsibility and its relation to the control condition, we were interested in views about responsibility attributions and the moral sentiments (e.g. pride, shame) related to scientific achievements or failures, including praise and blame as paradigmatic placeholders for the generic concept responsibility. Many of the participants, who stressed before that scientists exercise some form of control, also asserted that they can be proud of their work, at least, over those aspects they had control over. (a) Praise was specifically mentioned by one participant, who suggested that everyone needs a 'pat on the shoulder from time to time' as an incentive to keep on going. Other participants also expressed that reward fulfils a similar incentivizing function to attract new scholars to the field and stimulating people to work harder (see also Science policy). Likewise, another participant described that at his institute small successes were celebrated to keep up the positive spirit within the team given the high risks and the frequency of failure. Honouring and celebrating the successes was considered a way of motivating people and creating an optimistic research environment. Participants specified that the moral sentiment of pride (b) should be related to the agency part of a scientific contribution: If scientists tried hard and succeeded, even if luck was involved, they can be proud; not of the result, but of themselves for trying hard.

### Science policy

Several aspects of luck related to stratification, prizes and more generally the governance of science were addressed in the focus groups. These can be broadly subsumed under the umbrella term 'science policy.' We asked the participants specifically about prizes and their relation to personal desert by employing a variation of the drunken driver case, asking whether it would be fair to give a scientist, who is just as talented, hardworking and clever as a fellow scientist, but also luckier, a prize for her accidental discovery. The respondents referred to the following aspects in response: (a) value of prizes, (b) bias, (c) openness and risk-taking.

(a) The value of prizes was highly disputed amongst our participants. A few participants were outright critical and even suggested to abolish prizes. Others did not consider prizes as problematic at all. It was striking that to many participants, the choice of recipient of the prize was rather a matter of the social impact of the research than a question of comparative desert or fairness. Thus, it was readily acknowledged that the justification of prizes is often linked to external factors and not only to the personal desert of a researcher: The idea behind this seems to be that by showcasing the research and researcher on a public stage, society exhibits, which kind of research and outcomes are being highly valued. It was underscored that – just like the act of attributing praise (see Data collection) – the underlying motivation of prizes is to further **incentivize** the pursuit of the right research and motivating people to work harder. To the question whether prizes are a fair means to reward excellence, one respondent answered that prizes are awarded based on the outcome or impact, not based on the effort. He suggested that the results are important for deciding who should receive a prize. Simultaneously, several participants pointed out that prizes do **not** do justice to science as a **group effort**.

(b) One person was particularly outspoken regarding bias in reward procedures and argued that prizes in science are bad, because nominees are selected based on friendships and connections in the community, meaning that the most praiseworthy discoverers do not always receive prizes.

(c) Openness and risk-taking: Some participants suggested that funding bodies and similar scientific institutions are limiting scientific freedom to explore more unconventional research ideas or pursue unorthodox ideas through strict oversight over funded projects. A few participants explicitly criticized the duty to constantly report and being surveyed by funding bodies about their progresses. They asserted that this hampers potentially fruitful deviations from their research plans, which clashes with how their research would actually unfold: These participants evaluated these restrictions as detrimental to making fruitful discoveries. Furthermore, the participant who emphasized the virtue of courage also encouraged risk-taking in terms of pursuing unorthodox or far-fetched questions and exploring new directions that initially do not seem promising. The same person suggested the importance of sharing knowledge openly and 'prematurely' before publication to gain valuable feedback and new ideas from peers. We did not explicitly ask about the use of lotteries to allocate research funding, but the topic was mentioned in several focus groups. In one group, a senior researcher proposed to replace the review process of grants by research funding allocating completely based on luck (Fg4Sp4), which evoked affirmative responses by another participant in that group.

## Discussion

In this section, we will discuss our findings and relate them to the existing literature on moral luck, serendipity and RRI. Our study indicates that scientists are predominantly concerned with circumstantial luck and that they see ways of executing control in science. Moreover, our analysis shows that scientists perceive doing science as an effort to 'control' and eradicate luck in various ways, while being aware that they cannot exercise absolute control: They assert that in general, one will more likely succeed in science when employing the right skills and virtues. Such skills are seen as reasonable basis for pride. A clear-cut rejection or affirmation of prizes for discoveries, even if they had been made by accident, was not expressed. Oftentimes, the societal function of scientific stratification was put forward to justify that research without positive results cannot be rewarded, thus, defending the *status quo*.

### *Luck, control, and praise*

Neither the conclusion that moral luck is a paradox – which some philosophers drew (Nagel 1991, 34) – nor its complement that it does not exist, has been expressed by any of our participants. It is striking that through the insistence that one can exercise control ('It's not only luck, I had also been working hard to do some stuff and write this.') by learning a variety of skills or cultivating a number of virtues, many of our participants suggested that they can make a difference and influence their scientific success.[5] Setting up experiments based on the educated hypothesis regarding the expected outcomes, learning the skills of mastering a laboratory and gaining experience to detect anomalies largely represented their understanding of having control in science. To be in

control of one's research means mastering a number of experimental skills, being able to distinguish relevant features from noise, and – as several of our participants suggested – having relevant social skills (being able to network). A person, who has never seen the workings of an anti-septic agent probably would not have realized that the mould that entered Alexander Flemings' laboratory in 1928 caused an antibacterial behaviour pattern in the petri dish (Sand 2020; Copeland 2018). When confronted with the notion that two scientists, who employ these skills or virtues equally might still be unequally lucky and, hence, receive unequal reward for their work, our participants did not instantly reject reward mechanisms: Reward was, on the contrary, defended by some as having a social value in displaying what matters to society and incentivizing the quest to make similar finding, which has also been discussed in the social science literature (Zuckerman 1996, 1970). That such 'external' societal function could indeed be promoted to justify unequal treatment – if properly distinguished from the more basic concept of moral responsibility – has recently been suggested in philosophy of science and technology (Sand 2020; Strevens 2003). One of the central concerns of the moral luck debate – that it would be **unfair** to reward luckier scientists more than unlucky ones (Zimmerman 2015, 2019) – was not explicitly affirmed. Although, we specifically asked, whether prizes for luckier scientists would be unfair, the respondents did not reject prizes for this reason. One might explain this by emphasizing that not-receiving-a-prize does not equal the infliction of harm or adversity (such as a prison sentence for manslaughter, which the unlucky driver receives and the lucky driver not) (King 2014). This tentative explanation deserves closer inspection in future studies. In line with our findings, one might suggest that most scientists do, therefore, not entertain the same intuitions about the unfairness of punishment than about the unfairness of reward. In general, our participants suggested that luck does not make science a chaotic and unaccountable practice. They suggested that clueless people will not succeed in science, and, hence, reward is never completely baseless. It was argued that eager and hard-working individuals might not always succeed, they do so in general with the greater likelihood. For those, who are pursuing a scientific career, it seems, therefore, reasonable to train those skills and cultivate those virtues. Some participants expressed a striking concern with contemporary reward mechanisms in science, which is their disregard of the collective nature of scientific endeavours. Prizes are granted to individuals, but scientific successes are collectively achieved. This resonates with long-standing criticism of prizes rewarded solely to individual scientists or small groups, such as the Nobel Prize (Crawford 1998; Merton 1968).

### *Disjunction between the academic debate and our findings*

It is particularly interesting and worthy of being pointed out that there were a number of aspects prevalent in the literature on (moral) luck, serendipity and RRI that did not arise in any of our focus groups: (1) Serendipity (the unsought finding) was a rather minor concern, which might be because many of our participants were in an early stage of their career. Unsought findings were mentioned by a few participants, who picked up on hunches that turned out to become substantial discoveries – but when we asked for luck in science, most participants initially put forward other types of luck predominantly related to the social dimensions of science, aspects that were circumstantial: Whom they

meet, which projects they came along, which funding they received. Although some participants reported of sudden unexpected insights, e.g. under the shower, the stereotypical breakthrough encountered by chance, played a minor role in comparison to other forms of luck.[6] (2) The examples of luck in science as described by our participants also did not relate to an even more external view on science that has been brought forward recently by J.D. Trout (Trout 2019; Trout 2016): Trout suggests that the entire scientific project that emerged in the Renaissance in Europe is coincidental. Such holistic view on science and its relation to luck was not adopted by our participants. (3) Circumstantial luck was the type of luck most frequently mentioned. This has substantial implications for future empirical research on moral luck, which has predominantly focussed on resultant luck (cases like the drunken driver) (Kneer and Machery 2019; Lench et al. 2015). It seems clear – not only in the context of science – that circumstantial luck is closely intertwined with resultant luck: If an applicant does not get the grant she applied for, she misses an opportunity to do the intended research, thus, it is unlikely that she will yield results in this area: Hence, it seems – as suggested in the philosophical literature on moral luck – that some forms of moral luck 'stand or fall together' (Hanna 2014, 695; Mickelson 2019, 227).[7] Since our participants underscored the significance of circumstantial luck, the moral luck problem in science retains much of its force: Future research has to scrutinize, whether scientists believe that it makes a **moral** difference, for instance, which kind of people you meet during your career. (4) The relationship between luck and determinism commonly drawn in the moral luck literature, seems opaque to our participants (Nagel 1991, 37; Mickelson 2019). Determinism understood as the fixedness of the future undermines that anyone can influence what inevitably happens anyway – as incompatibilists commonly claim: There is no (ultimate) control over anything, ever. None of our participants mentioned determinism (causal luck) as a type of luck. This suggests three interpretations: It is possible that our participants entertain a **compatibilist view** about responsibility, freedom and control: They consider the types of control (skills and virtue), which they often underscored, as being 'immune' to determinism. Or – unlike many philosophers – they see no conceptual connection between control and determinism (Fischer 2012). Or, they asserted that determinism's truth would have wider implications than the present concerns about fair reward and success in science – in other words – that determinism constitutes a more general problem exceeding the questions we asked and the context of luck in science. (5) None of our participants alluded to 'constitutive luck,' which Nagel understands as luck in 'the kind of person you are, where this is not just a question of what you deliberately do, but of your inclinations, capacities, and temperament' (Nagel 1991, 28). No one expressed, for instance, having always been an easy learner or very prone to understand difficult intellectual work. This is in line with the strong emphasis that science requires hard work: Many participants experienced severe challenges in becoming scientists. It never felt easy. Here too, epistemic limitations might explain ignorance regarding this aspect: While they clearly notice that they have to exercise constant effort and master many challenges in their everyday work life, they might find it hard to imagine, how much harder less talented people have to work to understand intricate scientific subject matters. Another explanation to consider, is that our participants refrained from expressing such ideas about themselves, because they do not want to come across as being arrogant.

### Openness of science

In line with theoretical proposals to increase the chances for serendipity (Copeland 2018; Gillies 2015; Strevens 2003), we detected a tendency to value openness in science positively. Several participants wished having the liberty to leave the official pathway of their investigations to follow hunches and change the narrative of their research. Our participants emphasized that in these situations, they valued the liberty to do this and they spoke unfavourably of funding schemes that curtailed scientific liberties and minimized serendipitous potential. Thus, some participants supported the idea that high-risk endeavours (in terms of outcome uncertainty and deviation from official research plans) are funded. A considerable and concrete suggestion that was made to allow for deviations from workplans was to prolong funding periods: Grants that are allotted for short periods of time restrain the possibility of tinkering and pursuing unusual pathways. Furthermore, it was suggested that researchers, who have proven their excellence previously, should be provided funding not based on research ideas but on their quality as researchers. Aside from the openness in terms of loosening research from strict pre-formulated plans, some participants suggested that openness in terms of sharing preliminary results can be fruitful. Our participants understood 'openness' not as a more inclusive way of organizing science, e.g. by inviting the public into the laboratory and letting non-scientists participate in and co-determine research endeavours, which might be seen as ways of 'democratization of science' (Brown 2009) and which has been promoted as 'deliberativeness' and 'responsiveness' by several authors in the field of RRI (Owen et al. 2013, 38; Stilgoe, Owen, and Macnaghten 2013). Instead, 'openness' was understood as 'the commitment to make the tools and processes of science replicable and open to scrutiny,' which is a notion that has a long history in science and is equally bourgeoning and contested for its ambiguities in current science policy debates (Prainsack and Leonelli 2017; Levin and Leonelli 2016).

### Limitations

Some limitations pertain to this study: This work is exploratory in nature and subject to a number of limitations in terms of representativeness. Our sample is relatively small and participants were self-selected, which may mean that our participants are more receptive to and ready to discuss this topic than other scientists and engineers. Several scientists that had been approached and invited to join the focus groups, refused to participate in this study. The study team, therefore, decided to recruit via scientists in our network, meaning that we knew some of the participants before the start of the focus group. Still, the group size was relatively small, as only few people were willing or able to make time. Regardless of the relatively small sample, we had four lively and rich discussions and reached saturation in our data. Nevertheless, these empirical findings cannot be generalized to a broader population, even if our sample reflects the academic pyramid fairly well: We included many young scholars and relatively few late careers scholars. Similarly, the gender parity reflects the distribution of men and women in Dutch natural sciences and engineering sciences departments, which employ more male than female researchers.

## Conclusions and outlook

This last section starts with some recommendations for future research and ends with some reflections on the responsible governance of science in relation to the usage of lotteries for research funding allocation.

*Towards a more refined understanding of control in the moral luck debate*: In the moral luck debate, control is the central issue: The crucial difference between the lucky and the unlucky driver from Nagel's famous example – namely whether or not someone crosses the street – is beyond the control of the driver. Despite its centrality, the notion of control, however, is hardly ever specified in the moral luck debate. Helpful advances have been made by Rachel McKinnon and Ulrike Heuer, who suggested that training certain skills are a form of exercising control, which they exemplify with reference to playing poker and to being a professional truck driver (McKinnon 2014; Heuer 2016). Our findings suggest that the moral luck debate, which predominantly centres along the lines of the four categories of luck (resultant, circumstantial, constitutive and causal) mentioned above, complies with too crude an understanding of control. Our interviews revealed a more nuanced picture of control related to the **practice of science**: Our participants referred to skills, virtues, experience and preparation and to scientific work as being centrally concerned with controlling systems by making informed decisions. These notions are hard to square meaningfully with the rough concept of control that forms the nucleus of the moral luck debate. The need for a more fine-grained understanding of control beyond its binary understanding (either an agent had or had no control) has also been expressed in recent philosophical literature, where it was stated that the 'notion of control remains elusive' (Shabo 2020, 4). A more sophisticated understanding of control is required to do justice to our participants' main talking points: If control is a matter of skill, thoughtful preparation, e.g. by forming appropriate hypotheses, and experience, it is a much more gradual notion: Some people have more control than others. This more fine-grained account of control also has to consider different contexts of actions. Driving, playing poker or football, doing science: In each of these domains, preparing oneself and, thereby, increasing one's chances of success differ, and so does what it means to effectuate an outcome.[8]

*Studying the relationship between circumstantial luck, far-fetched counterfactuals and epistemic limitations*: One might wonder, why our participants did not instantly reject prizes that favour luckier scientists over equally hard-working unlucky ones. After one focus group, we shared the idea that comparing the efforts of real scientists to determine, who deserves a prize more, might fail due to epistemic limitations (Rescher 1995, 154): In reality, it is hard to know, whether two scientists were equally hard-working or skilful without reference to their actual achievements (which might be the result of luck). To this notion of 'epistemic luck' our participants responded affirmatively. One can suspect, based on this affirmation, that our thought-experiment about two equally skilled and talented researchers was too-far-fetched to evoke robust intuitions regarding deserving reward. The role of epistemic limitations for certain intuitions about moral luck cases is a promising focus for future research. This is particularly important, given the role that circumstantial luck plays according to our study: The effects of some circumstances are so hard to imagine and to predict that very few people develop robust intuitions about these prospects (The more far-fetched the counterfactual, the more it

stipulates one's imagination: What had you become, had you been born in different circumstances, say 150 years ago?).

*Lotteries and pride*: A recent publication suggests that humbleness is an important scientific attitude and that lotteries might induce such sentiments (Adam 2019). Economic studies of luck have suggested that humbleness might make one more likeable (and, therefore, potentially more successful) as a business partner (Frank 2017, 131 f.). For a number of other reasons, lotteries – which effectively introduce more luck into the decision-making processes about funding allocations – are increasingly praised as a tool for science policy: They supposedly make the process of funding allocation 'cheaper, more efficient, unbiased, and in several respects fairer and more reliable' (Roumbanis 2019, 5; Adam 2019). While these motives are laudable, the means to realize them must be assessed critically. While one of our participants spoke favourably of using lotteries for research funding allocation and another one underscored his worries about bias in determining awardees of prizes, the incentivizing function of praise and reward **for achievements** (also in terms of obtaining grants) was frequently underscored in particular in relation to motivational emotions such as pride. The motivational importance of **pride** must be taken seriously: While our participants acknowledged luck particularly regarding the social side of science, they also clearly pointed out that some scientists are better prepared than others to make scientific advancements. Training specific skills and cultivating specific virtues were seen as crucial steps to increase the chances of making valuable discoveries. Therein, they identify a form of **agency** of which scientists can be proud – even if ultimately unsuccessful. It was pointed out that there are so many failures and disappointments in science that one needs the occasional pat on the shoulder to keep going and stay motivated. This suggests that one ought to be careful in changing the stratification system in science and getting rid of prizes or rewards altogether, even if these institutions in their current form clearly require improvements towards impartiality and contra bias. Acknowledging luck even more by introducing lotteries, might undermine the **drive** behind many scientific enterprises. Reward mechanisms that relate to successes and the accompanying moral emotions are strong motivators to commit oneself to science and continue to venture into unknown terrain. As Robert Frank writes: '[…] pride in one's achievements is often one of the most powerful motivations to expend the effort it takes to succeed' (Frank 2017, 82). Future science policies must be careful to not undermine those sentiments by introducing more luck into academic career paths and randomizing achievements.

## Notes

1. It is notoriously difficult to define luck and serendipity and we have not presumed definitions of those concepts to maintain maximal theoretical openness in the focus group interviews. An unsought finding – as serendipity is often termed – can unexpectedly or luckily emerge not only from individuals, but also from a constellation of people that together pursue certain projects or ideas (Copeland 2017; Fine and Deegan 1996). Finding something unsought of can be the result of various kinds of luck (Van Andel 1994; Yaqub 2018; Roberts 1989). In the literature on luck, three conditions are usually mentioned in definitions of luck (all of them are contested): P is lucky regarding an event E, if E is unexpected, significant and beyond P's control. While all of these conditions are contested, the latter is considered to be most significant for **moral** luck (Enoch and Marmor 2007, 407; Rescher 1995). A person

cannot be considered lucky for choosing a job X against previous assurances to never switch jobs. Such decision might come unexpectedly (for bystanders), it is nevertheless within her control and hence not a matter of luck.

2. That this applies equally to practices of punishment, reproach and blame, has been outlined by the one of the authors (Sand 2020).
3. A nuanced discussion of the relationship between previous empirical studies and the philosophical problem of moral luck has been recently presented by (Kumar 2019).
4. Whether **moral** luck does exist, is heatedly debated in moral philosophy. Some philosophers argue that plain luck exists, but moral luck does not (Enoch and Marmor 2007; Enoch 2019). Others say that the control condition, which allegedly articulates common intuitions about moral responsibility, cannot consistently be upheld and has never been defended (Hartman 2019; Hanna 2014). A third position suggests that some forms of moral luck can be epistemically debunked (Rescher 1995). In this paper, we do not endorse a particular view on moral luck.
5. In this regard, our findings seem to differ most to those of Vik Loveday's previous study (2018), who reported that a majority of her participants underscored a lack of agency (and control) referring to precarious working conditions as a possible source thereof.
6. Although, Fine and Deegan consider meeting the right people as a form (or at least a source) of serendipity, too (Fine and Deegan 1996, 440).
7. Kristin Mickelson suggests in this manner that Nagel's classification might be seen more as four 'rhetorical "centers of gravity,"' and not as (ontologically) robust categories (2019, endnote 4). Nagel himself acknowledges the connection between circumstantial and resultant luck when writing: '[…] the circumstances that give our acts the consequences they have.' (1991, 37)
8. Whether this more temporally extended view on agency and control through the exercise of skills can satisfactorily debunk standard moral luck cases has been questioned (see Sand 2020): The drunken drivers do not differ in their skills or virtues, they are equally reckless. Their cases differ in outcome only and, hence, the air of paradox continues to surround those examples.

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