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Article

Peer review's irremediable flaws: Scientists' perspectives on grant evaluation in Germany

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Abstract

Peer review has developed over time to become the established procedure for assessing and assuring the scientific quality of research. Nevertheless, the procedure has also been variously criticized as conservative, biased, and unfair, among other things. Do scientists regard all these flaws as equally problematic? Do they have the same opinions on which problems are so serious that other selection procedures ought to be considered? The answers to these questions hints at what should be modified in peer review processes as a priority objective. The authors of this paper use survey data to examine how members of the scientific community weight different shortcomings of peer review processes. Which of those processes' problems do they consider less relevant? Which problems, on the other hand, do they judge to be beyond remedy? Our investigation shows that certain defects of peer review processes are indeed deemed irreparable: (1) legitimate quandaries in the process of fine-tuning the choice between equally eligible research proposals and in the selection of daring ideas; and (2) illegitimate problems due to networks. Science-policy measures to improve peer review processes should therefore clarify the distinction between field-specific remediable and irremediable flaws than is currently the case.

Keywords: peer review; problems; field of science; research grants; randomization.

1. Introduction

Scientists and research funders broadly agree that no better procedure exists for assessing and ensuring the quality of grant proposals than peer review. Only through that procedure do scholars evaluate research applications according to exclusively scientific criteria, providing for strict orientation to scientific quality. For this reason the peer review process is considered by many to be the model for procedures appropriate to science. Moreover, it represents the principle of self-governance in science and the field's relative autonomy vis-à-vis other social fields.

However, although peer review processes to discuss the merit of grant proposals are highly valued, they are also criticized and judged as flawed. Such contrary assessments explain both the heated debate about this review format and the reasons for the extensive scientific research now assessing the merits and problems of the procedure. It is frequently alleged, for example, that peer review is conservative and accords daring research proposals little chance (Luukkonen 2012; Boudreau et al. 2016; Lane et al. 2021); that necessary choices between applications of equal quality are often scientifically unjustified (Roumbanis 2019, 2020); that certain groups of researchers, including women and junior scholars, are structurally disadvantaged in this process (Langfeldt 2001; Sato et al. 2020); that reviewers tend to favour members of their own scientific networks (Jang et al. 2017); and that the process imposes an enormous burden on the reviewers and reviewed alike.

The shortcomings of peer review processes are often investigated, but the questions rarely arise whether scientists rank these flaws as equally problematic and which of them they deem so serious or irredeemable that they believe other selection procedures should be adopted. What differences can be found among scientists with regard to the valuation of problems with peer review procedures? How do scientists weigh the various defects? Which problems do they regard as less relevant? Which ones do they consider to be irremediable? Careful responses to these questions may make it possible to modify peer review procedures so that they are perceived as appropriate by researchers and are accepted by them.

These questions go beyond previous research on peer review processes. They are of great interest to science research because answering them can help improve the understanding of why peer review enjoys such great esteem and wide recognition despite the prevalent and harsh criticism of it. Grappling with them can also contribute significantly to a better-informed discussion about review processes, in particular about which limitations are acceptable and which deficiencies prompt scientists to advocate its modification.

In this paper we present results of a study on the evaluation of different ways of allocating funding randomly as potential alternatives to the peer review procedure. For this purpose a survey was designed to collect scientists' views on peer review processes in Germany and to reconstruct how scientists value lottery processes (randomization). Although acceptance of lottery procedures was the focus of the primary study (Philipps 2022), respondents additionally expressed differentiated views on drawbacks of peer review procedures. We focus this paper's analysis on the flaws of peer review processes directly related to agreements with randomly distributed funding, using a quantitative method to examine distributions and correlations.

In an utterly ideal-typical way the peer review process represents what Max Weber (1946: 350) determined to be

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characteristic of science: a great and principal 'rational achievement'. In this approach, decisions are made on the basis of scientific arguments. Random selection stands for exactly the opposite: a 'decision-making process by taking reasons out of the story' (Stone 2009: 392). According to Stone, the great advantage of a lottery is to 'ensure that bad reasons are unable to affect a decision' (375). Bad reasons are those that are wrong or those used merely as a pretext in absence of a reasoned decision (e.g. in case of indeterminacy). However, any form of random selection is immune to sound scientific reasoning or criteria that should be taken into account, such as fairness. From this line of thinking, we deduce that if scientists consider flaws of peer review processes to be so serious that they can imagine combining or even supplanting it with a lottery procedure, then these problems are unfixable because the scientists are in favour of a selection procedure that is contrary to the character of science. Similarly, we can inquire about problems to which they can*not* imagine responding with a lottery procedure because they perhaps consider them remediable through modifications of peer review processes.

We first review the research on peer review and random selection in order to elaborate theoretical foundations from Bourdieu's field theory on the scientific field's intrinsic structural antagonism and to derive hypotheses for our quantitative investigation. Our analysis draws on survey data and focuses on distributions and correlations between response categories, each combining assessments of peer review and lottery procedures. We then discuss the results and present a conclusion.

2. Shortcomings and problems of peer review processes

Studies on peer review processes to assess grant proposals have repeatedly criticized its lack of effectivity, asserting, for example, that peer review is unreliable, does not fund the best science, and is unfair (Ismail, Farrands and Wooding 2009; Guthrie, Ghiga and Wooding 2018). A fundamental issue is that reviewers rarely reach consistent conclusions in peer review (Pier et al. 2018; Brezis and Birukou 2020). The studies on peer review primarily identify the following four additional deficiencies.

2.1 Peer review processes are conservative

Several studies on the 'conservative bias of the peer review' (Luukkonen 2012: 49) document the preference reviewers have for conventional research projects that assure a high degree of feasibility (e.g. Chubin and Hackett 1990; Langfeldt 2001; Boudreau et al. 2016; Ayoubi, Pezzoni and Visentin 2021). Some studies have investigated how and why research traditions, personal involvement, and other interests may promote a conservative bias in peer review processes (Chubin and Hackett 1990: 62; Travis and Collins 1991). Other research has scrutinized the effects of funding programs, notably those created to sponsor 'high-risk and outside-the-box research' (Heinze 2008: 303; Laudel and Gläser 2014; Van den Besselaar, Sandström, and Schiffbaenker 2018). These scholars wanted to find out the extent to which particularly heterodox projects benefit from such initiatives. Overall, they concluded that the conservative wariness inherent in peer review appears to apply even to those funding schemes. For example, Heinze identified a 'tension between plausibility and scientific value of the research' and 'its originality' (Heinze 2008: 302). Even when funding bodies explicitly call for risky and original research ideas, applicants present their project in ways intended to satisfy the conservative bias of the peer review (Philipps and Weißenborn 2019; Barlösius and Blem 2021). This decision demonstrates that researchers firmly believe that peer review is conservative, even when they are expected to do the opposite.

2.2 Peer review selection procedures do not work for qualitatively equivalent or incommensurable research proposals

The promise of the peer review process is that only scientific quality should be decisive. However, the legitimacy of the procedure reaches its limits if research proposals are judged to be scientifically equivalent or utterly incomparable and a selection is nevertheless made. Problems arise when reviewers have to differentiate between proposals from scientists working on similar research topics, operating with comparable or identical disciplinary approaches, promising ground-breaking scientific results, and, in many cases, exhibiting equally high quality. Difficulties surface also when reviewers have to distinguish between proposals that defy reasonable comparison because they come from different research fields, work with completely different methods, and pursue quite separate goals. In short, such proposals are incommensurable and preclude a properly scientific decision, making fine differentiations between research proposals all but impossible for reviewers (Lamont 2009; Luukkonen 2012; Roumbanis 2019). Even peers who are familiar with the theories, methods, and body of knowledge in their discipline are not always able to rank the eligible proposals in a peer review process based on scientific merit. Elster (1989) suggests that this predicament in the field of science owes to the overestimation of science-driven evaluations of research ideas. Although peer review processes are intended to ensure that research adheres to scientific standards, not all aspects of research (e.g. originality and relevance) can always be weighed according to qualitative scientific criteria. Such situations give rise to indeterminacy, which is often resolved through scientifically illegitimate assessments and criteria in order to rank the proposals (Lamont 2009). The reviewers 'cannot always judge and compare the content in different application in a consistent manner', (Roumbanis 2020: 131) an insight that explains why the peer reviews' orientation solely to scientific criteria is disputable.

2.3 Peer review procedures are not impartial to different groups of researchers

A common criticism of peer review processes is that reviewers practice several kinds of bias. Various studies have shown that women (Kaatz et al. 2016), applicants of colour (Ginther et al. 2011), and early-career researchers (Tabak and Collins 2011) are disadvantaged in the allocation of research funding. The literature distinguishes between 'individual and systemic biases' (Sato et al. 2020: 150). Individual biases 'are considered to be shaped by stereotypical beliefs in academia', and systemic bias 'refers to grant scheme design and grant evaluation criteria that unequivocally place men in favourable positions' (Sato et al. 2020: 121). Disadvantaged groups of researchers experience peer review processes as a 'clear obstacle' to their academic career (Roumbanis 2020: 131).

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Privileging established scientists by peer review is interpretable as an example of what Merton (1968) called the Matthew Effect of accumulated advantage, in that their proposals often benefit from advance credit. The third deficiency is thus that the reviewers do not limit themselves to evaluating the project; instead, they are guided by biases and stereotypes and wind up ignoring the academic norm of impartiality in review processes.

2.4 Peer review procedures are not disinterested

Disinterestedness is a central scientific norm already described by Merton, but it is one to which peer review practices do not always adhere. The interests that reviewers pursue include privileging their academic networks, cultivating cronyism, and pursuing strategic preferences. According to Vallée-Tourangeau et al. (2022: 9), favouring one's own academic networks and cultivating cronyism can be called 'familiarity bias'. In a study on alumni connections between the evaluators and those they evaluate, Jang et al. (2017: 117) showed that the former group has 'a tendency to give . . . higher scores to research proposals by alumni of . . . their alma mater'. The authors also found that if there are 'alumni among the evaluator group, the rate of successful selection for funding is higher' (132). The fact that personal bias and interests influence the review and selection process undermines the integrity of peer review processes. There are also several other inadequacies and problems less frequently addressed and scientifically investigated, including 'theft' of research ideas during review processes, sloppily and poorly conceived written expert opinions, and stressful and time-consuming writing of research proposals (Herbert et al. 2014; Guthrie, Ghiga and Wooding 2018; Barlösius and Philipps 2022).

Despite the long history of discussion about peer reviews' flaws, there has been no investigation of whether they are all thought to be critical enough to warrant a different selection procedure. Lottery procedures are, in principle, the opposite of scientific peer review processes, so scientists' contemplation of using them to address certain problems indicates that the deficiencies in question are valued as irredeemable, whereas no alternative evaluation process has been proffered.

3. Varieties of lottery procedures

A central argument for substituting randomized selection for peer review suggests that it would repair the deficiencies detailed above. It is said that randomization makes it possible to select between research proposals independently of scientific quality, so there would be no need for comparison (Stone 2009; Roumbanis 2020). Randomization would accord all applications the same chance of selection, no matter who submits them. A wide range of biases would be eliminated, and social networks or cronyism would not play a part in the process. This approach, however, would make scientific quality and performance irrelevant. It would lack any factual justification and would thus suspend scientific quality control and scientific conservatism, a move alien to science.

Nonetheless, scholars discuss the usage of lotteries for allocating grant money, emphasizing its impartiality (Roumbanis 2019; Horbach, Tijdink and Bouter 2022) on the one side and pointing out its ignorance of scientific merit on the other (Bedessem 2020; Reinhart and Schendzielorz 2020). In fact, surveys among scientists (Liu et al. 2020; Reinhart and Schendzielorz 2020; Philipps 2022) show that the majority would reject pure randomization but would be open to partial lotteries—as is practiced by some funding organizations that have implemented random elements in their peer review processes. Funders such as the New Zealand Health Research Council (HRC), the New Zealand Science for Technological Innovation (SfTI), and the Swiss National Science Foundation (SNSF) use randomized allocation processes in selected lines of funding to award research grants to applicants. The organizations employ different procedures. The SfTI funding line and the SNSF draw lots to decide which of the eligible research proposals to fund. The HRC, on the other hand, resorts to the lottery procedure if there are more eligible applications than funding available.

The current discussion of random elements in peer review processes, however, hardly examines for which deficiencies of peer review processes scientists could imagine the introduction of lottery procedures. What is seen as challenging but could be solved using specific scientific practices? Which groups of scientists tend to favour lottery procedures more than other scientists do?

4. A rationale structured by antagonism between orthodoxy and heresy

Max Weber (1946: 350) described science as the sphere with the 'greatest and most principled' rationality, which for him culminated in the fact that 'all scientific observations strive for clarity and verifiable accuracy of insight and comprehension' (Weber 1978: 5). Science thus represented for him the sphere in which reasoning is characteristic. Contradicting a view centred on the autonomy of science, Pierre Bourdieu (2004) argued that the scientific field is a social field like any other and, accordingly, has many things in common with other social fields. Like the field of art, it is structured by an antagonism between orthodoxy and heresy.[1] In the scientific field it has functional significance because it ensures the generation of original (heterodox) knowledge while simultaneously guaranteeing that it conforms to the orthodox standards of science. This antagonism pervades all institutions and procedures of the scientific field, including, of course, the peer review process.

For lottery procedures, Barlösius and Philipps (2022) have shown that antagonism results in dilemmas largely aligned with the nomos (the field's own rules and claims as well as its internally developed forms of practice and instances of consecration). They have referred to these dilemmas as legitimate quandaries because they are structurally endemic to peer review processes themselves; that is, they do not arise from any misuse of the processes. Essentially, there are two quandaries involved. The first arises from the fact that peer review has to assess the originality of a research idea while also checking whether it is feasible, an assessment possible only through established research knowledge. Hence, peer review is of limited use for evaluating risky and daring research. The second quandary stems from the fact that differences in scientific quality should be the only decisive factors in review processes but that they are often undeterminable with scientific precision when equivalent or incommensurable proposals are under consideration. In these two situations peer review procedures do not function as intended by the scientific field; they cannot deliver a purely scientifically based selection decision.

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Barlösius and Philipps (2022) have also identified illegitimate problems in peer review processes. They stem from disregard for, or insufficient attention to, the field's internal rules governing the practice of peer review. Reference to seniority, reputation, or further criteria other than scientific quality makes the procedures depart from their original function and tends to undermine their legitimacy. If networks, cronies, or strategic preferences influence peer review processes, illegitimate problems arise because the rules are violated. Given the broad knowledge about these problems, insufficient care to preclude corrosion of peer review processes can also be branded as an illegitimate practical application of them.

Scientists presumably evaluate legitimate quandaries differently from illegitimate problems in peer review. They also discuss different processing and solutions. On the basis of their qualitative study, Barlösius and Philipps (2022) believe that scientists tend to argue in favour of using lottery procedures for legitimate quandaries, which are inherent in peer review processes. The authors further postulate that scientists rate the severity of illegitimate problems according to whether they see themselves as affected by them. Scientists for whom illegitimate problems are of little relevance will presumably welcome lottery procedures less often than will those who assume that they could be disadvantaged by such problems.

5. Hypotheses

In this study we investigate and test the relationships postulated by Barlösius and Philipps (2022). We take the distinction between legitimate quandaries and illegitimate problems in peer review procedures and translate it into good and bad reasons for using lottery procedures. To do so, we assume that scientists have good reasons to support randomization in cases of legitimate quandaries, that is, when adherence to peer review procedures would very probably engender non-scientific justifications of decisions. This outcome is particularly likely when such reviews focus on proposals of equal or incommensurable merit or on risky research ideas. In these cases, peer review processes may reach a point where it becomes difficult to formulate purely scientific justifications for the acceptance or rejection of a proposal. We conjecture that scientists consider such non-scientifically based decisions to be 'bad reasons' (Stone 2009: 375) for adopting peer review processes. If, on the other hand, decisions were to be arrived at through lottery procedures, no reasons would need to be given and it would be possible to avoid doing so. Because legitimate quandaries are embedded in peer review processes, all scientists are equally affected by the resulting deficiencies. Lottery procedures will therefore likely meet with majority approval in these cases.

> *Hypothesis 1*: When legitimate quandaries surface in peer review processes, the majority of respondents will agree with the use of lottery procedures to accept or reject research proposals.

The findings of Barlösius and Philipps (2022) also suggest that illegitimate problems, such as the strategic preference for one's own networks and the disadvantaging of female scientists, are considered bad reasons for using peer review processes to judge the merit of research proposals. Evidencing non-compliance with procedural rules (misconduct), they differ fundamentally from the bad reasons mentioned above. When illegitimate problems are involved, one may expect the attitude of scientists towards lottery procedures to be different than in cases of legitimate quandaries. Lottery procedures could preclude such bad reasons but would also be blind to good reasons, such as scientific originality and feasibility. Accordingly, lottery procedures would presumably meet with little approval in the case of illegitimate problems.

> *Hypothesis 2*: When illegitimate problems surface in peer review processes, the majority of respondents will reject the use of lottery procedures in the selection of research proposals.

The studies by Barlösius and Philipps (2022) and Philipps (2022) indicate that respondents differ in their perception of legitimate quandaries and illegitimate problems surrounding peer review processes and in their openness to the use of lottery procedures. They suggest that scholars without jury experience in grant-funding seem to perceive structural disadvantages more acutely than more experienced reviewers do and seem to demand equal opportunity for all groups to participate. Peer review processes should ensure that prejudices against certain groups cannot come to bear on the review processes. Despite such observations and exhortations, structural disadvantages have not diminished in recent decades. Scientists without relevant jury experience therefore presumably see randomization above all as procedures that treat everyone equally irrespective of personal characteristics and that thereby purge grant-funding decisions of bad reasons relating to beliefs and stereotypes. This group of scholars will thus likely be significantly more in favour of lottery procedures to purge disadvantages than will be the case with scientists who have jury experience.

> *Hypothesis 3*: Inexperienced scientists perceive deficiencies in peer review processes more often than their experienced colleagues do *and* are more likely to agree with the use of lottery procedures as a remedy.

Philipps (2022) also suggests that female and male scientists differ in their perceptions of legitimate quandaries and illegitimate problems in peer review processes. Indeed, the percentage of our sample's academics who suspect that women are disadvantaged in peer reviews is larger among the women than among the men. Coupled with research showing that female scientists must perform better than their male counterparts to receive comparable ratings (Kaatz et al. 2016; Severin et al. 2020), we expect that female scientists will be more likely to see defects in peer review processes and be more open to the use of lottery procedures than male scientists will be.

> *Hypothesis 4*: Female scientists are more likely than male scientists to perceive shortcomings of peer review processes *and* are more likely to agree with the use of lottery procedures as a remedy.

Lastly, we propose that the assessments by scientists who are against randomization in principle change if certain legitimate quandaries and certain illegitimate problems arise in peer review procedures. This change can be interpreted to mean that scientists see these problems as irremediable deficiencies. In the qualitative studies by Barlösius and Philipps

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(2022) and Philipps (2021), an openness to lottery procedures had unexpectedly emerged even among respondents who thought peer review procedures to have no alternative. They reported willingness to imagine some lottery elements being included in peer reviews in which bad (non-scientific) reasons were very likely to affect decision-making. These responses suggest that they see randomization as justifiable in such special circumstances as a way to address irreparable flaws of peer reviews without undermining their special status as a highly regarded scientific procedure. In this study we therefore consider which of peer review's deficiencies are deemed beyond repair. Those weaknesses would be those for which a remedial use of randomization could be contemplated even by scientists who fundamentally reject lottery procedures.

> *Hypothesis 5*: If a majority of respondents who fundamentally oppose lottery procedures nevertheless favour uses of lottery procedures to address certain deficiencies, then those deficiencies are beyond repair.

6. Data and method

For this study, we reanalyse available data from a survey of scientists' perspectives on peer review procedures and on randomization as potential alternatives. The survey included scientists from universities and non-university research institutions in the German federal state of Lower Saxony who were qualified to apply for funding. To this end the websites of selected institutions were scanned in autumn 2020 for entries and e-mail addresses of researchers with doctorates in the humanities and social sciences, life sciences, natural sciences, and engineering. In January and February 2021 an e-mail was sent to 2150 scientists with an invitation to complete an anonymous online survey via LimeSurvey. The survey was open for six weeks, with a reminder being sent to the invited scientists after three weeks. A total of 224 questionnaires, which is a response rate of 10.4%, were completed and could be used for our investigation. This response rate is suitable for an online survey because response rates of online surveys are in general lower than in other survey methods (Daikeler, Bosnjak and Lozar Manfreda 2020). Further reasons partially explain non-responses. First, random funding does not seem to be a highly relevant topic to most researchers. Second, the questionnaire circulated only in German, excluding the non-German speakers in the selected academic institutions.

The design of the online questionnaire was based on previously conducted qualitative interviews on this topic (Philipps 2021). The survey included fifteen closed questions covering topics such as the perceived situation of funding in Germany, the functionality of peer review procedures, different ways to use random elements in peer review processes, assumed benefits and deficiencies of lotteries, sociodemographic information, and the respondent's own participation in peer review processes. Recurrently mentioned observations and assumptions about peer review and randomization were transferred from the interviews to the survey (see Philipps 2022) in order to check what other scientists think about the topics of interest. Importantly, propositions in the questionnaire used amplifications. In other words, respondents did not indicate any shortcomings but instead made qualified statements that a 'majority' is engaging with peer review procedures in certain ways (e.g. giving higher rating to research projects based on preliminary work than to those without such input).

Moreover, we created counterparts from the complementary questions on peer review and expected impacts of lottery procedures. Regarding the variable 'networks', for example, we constructed the counterparts by using the responses to the item on peer review ('Applicants have an advantage if they know the reviewers personally.') and the item on randomization ('Randomization reduces disadvantages through networking.'). From these counterparts we developed countervariables (see Supplementary Appendix A), which we used in our further statistical analysis; two cases with too many missing values in this regard were deleted. The sample was thereby reduced to $N = 222$ cases. Of these respondents, 59 (27%) were women, 158 (71%) were men, and 5 (2%) described themselves as diverse. Most of the respondents (124, or 56%) were academics without a professorship; 98 (44%) were professors. A total of 152 respondents (68%) held permanent positions; only 70 (32%) held temporary positions. In all, 153 respondents (69%) were employed at universities or universities of applied sciences; 42 (19%) at non-university research institutions; and another 27 (12%) at both a university and a non-university research institution. The classification into subject areas followed the system of the German Research Foundation (DFG), with 71 respondents (32%) placing themselves in the natural sciences, 66 (30%) in the life sciences, 62 (28%) in the engineering sciences, and 23 (10%) in the humanities and social sciences.

This study examines academics' views on and experiences with peer review procedures in conjunction with their approaches to randomization. We follow Barlösius and Philipps (2022) in differentiating between legitimate quandaries and illegitimate problems in processes of peer review and in recording whether or not participants indicate that random elements might be a solution to these failings. We also investigate differences regarding gender (women and men) and the degree of experience with grant juries. The degree variable distinguishes between those respondents who have had broad experience with jury processes for allocating research funding (experienced) and those who may have had experience with writing reviews but not with actually deciding on grants (inexperienced). The respondents in the latter group have successfully pursued a scientific career and earned scientific and institutional capital, but they were not currently in positions to decide on funding and on research direction in the scientific field. In our sample 215 scientists had already written a review, 70 had participated in a jury for an individual project and 65 for a collaborative project, and 26 scientists had already sat on the Review Board of the German Research Foundation. We defined experienced academics as those who had served in at least one type of jury. We regarded 89 (40%) of the scientists in this study as experienced; 133 (60%), as inexperienced. The size of our sample does not allow intersectional analysis, for the number of female scientists is too small, which is characteristic for the natural sciences in Germany.

We used the filter guide in the questionnaire (see Supplementary Appendix B) and grouped the participants according to whether they could generally imagine and agree with the usage of pure or partial random selection (agree with randomization) and those who could not imagine any form of random selection under any circumstances (disagree with randomization). In our sample 159 respondents (72%) were

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open to a new, complementary procedure such as a lottery. This group included those who would allow pure randomization (22%) and all those who are open to combining a lottery with peer review (63%) or with a scientific panel (64%). A total of 46 (21%) participants expressed a clearly negative attitude towards random procedures; and 17 (8%) neither agreed nor disagreed regarding random selection. Using the filter guide, we subsequently excluded the last group from our analysis in order to clarify positions between agreement and disagreement. We scaled the items of the questionnaire by following Philipps' (2022) modification of the 5-point Likert scale ranging from *strongly agree* to *strongly disagree*. Because some items in the questionnaire involved very small numbers, we also merged *strongly agree* and *tend to agree* as well as *strongly disagree* and *tend to disagree*. All results in this document have therefore been grouped into *agree, undecided*, and *disagree*.

For the analysis we drew on Barlösius and Philipps' (2022) observations to form countervariables for comparison with each other in our study. Statistical significance tests were subsequently carried out in STATA (version 16.1) in order to check whether the observed frequencies of the variables matched the expected frequencies at a 95% confidence level. The Spearman rank correlation yields information on the degree of relationship between two variables from weak (<0.2) to strong (>0.8). There were consistently highly significant and positive correlations between the counterparts of variables, so we do not discuss the statistics in detail but rather provide them in Supplementary Appendix C. Lastly, the formulated counterparts of variables were cross-tabulated with the variables gender, degree of jury experience, and agreement or disagreement with randomization. For this step we calculated the levels of significance with Cramér's V, which measures the degree of relationship between two variables from weak (<0.1) to strong (>0.5).

7. Results

We not only calculate agreement, indecision, and disagreement regarding lottery procedures for problems in the peer review process but also reveal for these three categories the group-related proportions for the agreement on using any form of lottery. We are thereby able to demonstrate that even those respondents who did not see a specific problem in peer review, could imagine (sometimes to a high degree) that lottery procedures could be an alternative. These percentages of agreement are revealed only in the Supplementary Appendices and are mentioned in the text when they are of special interest. We first consider the two already mentioned legitimate quandaries posed by the peer review process—the fine differentiation between equally eligible research proposals, and the selection of daring ideas (see Table 1).

In the first group—those who agree that legitimate quandaries prevail in peer review processes—a clear majority of the respondents (60%) both perceived a problem with fine differentiation and favoured using any form of lottery procedure. Only 8% of those who saw this quandary were undecided or disagreed to the use of the lottery procedure in the context of fine differentiation. These findings clearly demonstrate that scientists agree that there is a quandary in peer review processes and mostly accept an alternative. However, a particularly interesting pattern emerges when group-related proportions are considered. In the disagree group 51% of the respondents and as many as 85% in the undecided group indicated that they would use the lottery procedure for research proposals that are equally worthy of funding, even though the quandary of fine differentiation in peer review processes was not obvious to them (for further details see Supplementary Appendix D).

Table 1. Responses to legitimate quandaries in the peer-review process (in percentages)

Countervariable: peer-review/lottery procedure	Fine differentiation	Daring ideas
'Agree' group		
Agree/agree	60	54
Agree/undecided	4	6
Agree/disagree	4	2
Subtotal	68	62
'Undecided' group		
Undecided/agree	12	7
Undecided/undecided	1	3
Undecided/disagree	1	3
Subtotal	14	13
'Disagree' group		
Disagree/agree	9	13
Disagree/undecided	5	4
Disagree/disagree	4	8
Subtotal	18	25
Total	100	100

Similar results were obtained for the second quandary—the selection of proposals with daring research ideas. In the agree group, a total of 54% of the respondents were convinced that the selection of these proposals surfaces during peer review and considered the lottery procedure to be a possible solution. Again, only 8% of those who were undecided or against the use of lottery also saw this quandary in the context of daring ideas in peer review processes. When considering the group-related proportions (see Supplementary Appendix D) once more, it emerges that both the undecided (55%) and the disagree group (51%) would agree to the use of a lottery procedure when it is a matter of daring ideas.

This result resembled that for fine differentiation. There was thus an overall great willingness to deal with legitimate quandaries in peer review processes by resorting to elements of randomization. Even respondents who did not observe these two problems were nevertheless able to imagine a lottery procedure if applications could not be ranked in a scientifically justified manner or if it were not possible for daring research ideas to be reviewed on an exclusively scientific basis. These two problems thus appear to be irremediable flaws, a finding that confirms Hypothesis 1.

Next, we consider three manifestations of the three identified illegitimate problems of peer review processes (see Table 2): (1) reviewers favour their own networks, (2) female scientists are disadvantaged by peer review processes, and (3) proposals from early-career researchers are rejected more frequently than are proposals by established researchers.

Initially, with regard to the agree group, a large majority of respondents (59%) shared the view that applicants have an advantage if the reviewers know them personally. These participants saw the lottery as a way to neutralize such advantages. Only a few of the respondents were undecided about (6%) or disagreed with (4%) the use of a lottery to circumvent possibly existing networks in peer review processes. Examination of the group-related proportions (see

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Table 2. Responses to illegitimate problems in the peer-review process (in percentages)

Countervariable: peer-review/lottery procedure	Networks	Young researchers	Women
'Agree' group			
Agree/agree	59	19	10
Agree/undecided	6	1	0.5
Agree/disagree	4	1	0.5
Subtotal	69	21	11
'Undecided' group			
Undecided/agree	8	13	11
Undecided/undecided	4	7	14
Undecided/disagree	6	6	5
Subtotal	18	26	30
'Disagree' group			
Disagree/agree	7	16	6
Disagree/undecided	–	14	22
Disagree/disagree	5	23	31
Subtotal	12	53	59
Total	100	100	100

Supplementary Appendix E) makes it apparent that, even among those who did not suspect network influences, 57% (in the disagree group) and 45% (in the undecided group) would use lottery procedures to prevent existing networks.

Next, our study addressed the problem that reviewers often have more reservations about proposals from early-career researchers than from experienced scientists. In the agree group, which believed that lottery procedures would eliminate this illegitimate problem, 19% of the respondents favoured their use. More interesting is the fact that most respondents did not share the impression that scientists are at a disadvantage early in their career. Accordingly, this set of participants was opposed to lottery procedures (disagree group). Despite all this, the group-related proportions (see Supplementary Appendix E) reveal that even those who did not observe any disadvantages in peer review processes for young researchers would agree to the use of lottery procedures (31% in the disagree group and 50% in the undecided group) to circumvent any possible discrimination.

With regard to discrimination against female scientists, only 10% of the agree group believed that a large share of reviewers are guided by negative prejudices against women and are in favour of lottery procedures. By contrast, 59% of respondents did not believe that women face disadvantages in peer review processes. Among the agree group—who believe that women face discrimination in peer review processes—84% could imagine lottery procedures for solving this problem. Interestingly, only 10% of the disagree group would agree to make use of randomization to circumvent possible discrimination against women.

On the whole, the majority of respondents therefore did not observe any disadvantages for early-career researchers and women and rejected the lottery procedure as a remedy for these problems. No consistent picture of the illegitimate problems emerged overall, so Hypothesis 2 must be rejected in general for them. Although the majority of respondents indicated that they believed network effects are operative in peer review and that they could imagine using lottery procedures, few of them assumed that early-career scientists and women are disadvantaged and that lottery procedures should be used. The respondents thus at least had the impression that network effects are one of peer review's deficiencies that cannot be remedied and would therefore address them more vigorously. The assessments of the disadvantages of early-career researchers and women should, however, be viewed cautiously and are possibly influenced by the composition of our sample.

In the next step, we looked at all the respondents who perceived a legitimate quandary or an illegitimate problem in the peer review process and simultaneously supported the use of randomization. Depending on the degree of jury experience the respondents had, there is a generally high level of support for legitimate objections to peer review processes (60%) and for the use of a lottery procedure as an alternative (54%) (see Table 3).

Of the scientists regarded in this study as inexperienced in jury processes, 66% perceived a quandary in peer review processes with regard to the fine differentiation of research proposals that are equally worthy of funding and simultaneously saw the use of lottery procedures as a potential alternative. Only 52% of the experienced scientists held the same view. Cramér's V indicated a highly significant moderate correlation. The opposite picture emerged when the applications of daring research ideas were considered: Only 52% of the inexperienced and 57% of the experienced scientists identified a quandary and agreed with use of lottery procedures.

With regard to illegitimate problems, 59% of the respondents criticized the influence of networks in peer review processes and agreed with the lottery as a potential alternative. In terms of the degree of jury experience, 67% of the inexperienced scientists held this position as compared to 47% of the experienced scientists. Only 19% of respondents agreed with the statement that early-career researchers are treated disadvantageously in peer review processes and that lottery procedures could remedy this problem. Whereas 26% of the inexperienced researchers recognized the problem and acknowledged lottery procedures as an alternative, the corresponding figure for the experienced researchers is only 7%. Cramér's V indicates a moderate correlation, which is statistically highly significant. Only 10% of the respondents viewed discrimination against women as a problem in peer review processes and supported the use of lottery procedures. Some 14% of the scientists inexperienced in jury processes agreed, whereas only 2% of the experienced scientists acknowledged the flaw and the potential alternative. Once again, Cramér's V signifies a moderate, statistically highly significant correlation.

Overall, we found that the inexperienced scientists tended to perceive the illegitimate problems in the peer review process more often than the experienced scientists did and are more likely to agree with the use of lottery procedures as a remedy. We therefore see confirmation of Hypothesis 3.

We now come to the fourth hypothesis, where we compare female and male respondents. Once again, there is a generally high level of agreement on the existence of the legitimate quandaries in peer review procedures and lottery procedures as alternatives (60% and 54%, respectively; see Table 4).

With regard to the fine differentiation between equally eligible proposals, men rated this quandary somewhat higher and supported the lottery procedure as an alternative more than women did (62% and 56%, respectively). In the case of proposals with daring research ideas, it emerged that 56% of men and 49% of women see peer review processes as a quandary that could be resolved by lottery.

When it came to illegitimate problems, the picture blurred again. In particular, the respondents mentioned existing

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Table 3. Agreement, as a function of the respondents' jury experience, that peer review is flawed and that randomization may be an alternative (percentages)

	Response category	Agreement about peer review and randomization	Degree of jury experience		P values	Cramér's V
			Inexperienced	Experienced		
Legitimate quandaries	Fine differentiation	60	66	52	0.004**	0.319
	Daring ideas	54	52	57	0.164	0.230
Illegitimate problems	Networks	59	67	47	0.061	0.247
	Young researchers	19	26	7	0.000***	0.381
	Women	10	14	2	0.000***	0.405

** $P < 0.01$, *** $P < 0.001$.

Table 4. Agreement, as a function of gender, that peer review is flawed and that randomization may be an alternative (percentages)

	Response category	Agreement about peer review and randomization	Men	Women	P values	Cramér's V
Legitimate quandaries	Fine differentiation	60	62	56	0.503	0.184
	Daring ideas	54	56	49	0.830	0.141
Illegitimate problems	Networks	60	61	57	0.845	0.126
	Young researchers	19	18	22	0.375	0.199
	Women	10	4	24	0.000***	0.387

*** $P < 0.001$.

networks as a problem in peer review processes and thought it could be resolved by lottery (60%). Men agreed with both views somewhat more often than women did (61% and 57%, respectively). By contrast, respondents overall expressed less support for the statement that peer review processes were disadvantageous for early-career researchers (19%) and women (10%). Early-career researchers were said by 22% of women to have less chance of success in peer review processes than established scientists do and that the lottery procedure could lead to fairer decisions. The share of men who agreed with that view is four percentage points lower. Discrimination against female researchers in peer review processes was also more likely to be identified as a problem by women than by men. Whereas only 4% of the men indicated that the use of lottery procedures could address the problem, 24% of women were in favour of randomization. In this particular case Cramér's V indicates a moderate relationship, which is highly statistically significant. In short, Hypothesis 4—the assertion that female scientists are more likely than male scientists to perceive shortcomings of peer review processes *and* are more likely to agree with the use of lottery procedures as a remedy—was not confirmed.

Lastly, we examined whether respondents who are fundamentally against randomization nevertheless favour it when certain deficiencies of peer review procedures arise, allowing the assumption that irremediable deficiencies exist.

With respect to the fine differentiation of equally eligible proposals and to proposals with daring research ideas, 59% of those respondents who opposed the use of lottery procedures were nevertheless in favour of it for such decisions (see Figures 1 and 2). Only 19% and 24%, respectively, continued to reject the use of a lottery. A further 22% and 17%, respectively, positioned themselves between the two answer categories.

Around 52% of the respondents who generally had a negative attitude towards lottery procedures favoured their use to prevent existing networks from leading to unequal treatment in peer review processes (see Figure 3). Only 39% continued to reject lottery procedures as an alternative for mitigating existing problems in peer review processes. Another 9% of the respondents were undecided about applying lottery procedures for this purpose.

As with illegitimate problems in general, the question of whether there was discrimination against early-career researchers and women in the peer review process elicited a contrary picture. Only 18% of the respondents who opposed lottery procedures could imagine randomization in order to reduce possible discrimination of young researchers. When it came to possible discrimination of female researchers, the agreement reduced even more; only 9% agreed with lottery procedures to circumvent this disadvantage (see Figures 4 and 5).

The use of a lottery continued to be rejected by 69% in the case of young researchers and by 63% in the case of female researchers. Regarding the early-career researchers, 13% of the participants were undecided on this matter, but 28% were unsure whether a lottery is a suitable alternative for combating discrimination against women.

Because the majority of respondents to the items on fine differentiation, daring ideas, and networks agreed on the use of lottery procedures although they had not previously seen any alternative to them, these cases presumably reflect irremediable deficiencies in peer review processes in the sense of Hypothesis 5. On the other hand, the respondents seemed to regard disadvantages of early-career researchers and women as remediable flaws.

8. Discussion

Research has identified various problems with peer review processes (Ismail, Farrands and Wooding 2009; Guthrie, Ghiga and Wooding 2018) and has discussed modifications and alternative processes (Guthrie et al. 2019). By contrast, Barlösius and Philipps (2022) proposed that categorical differences between the various defects in peer review procedures should be considered, and they introduced the distinction between legitimate quandaries and illegitimate problems for this

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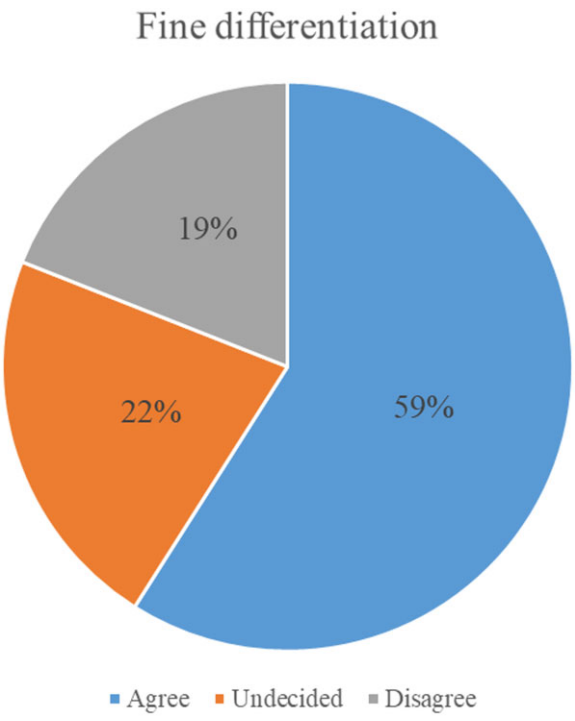

Figure 1. Breakdown of responses to the question of whether a lottery procedure should be used when the limits of fine differentiation have been reached.

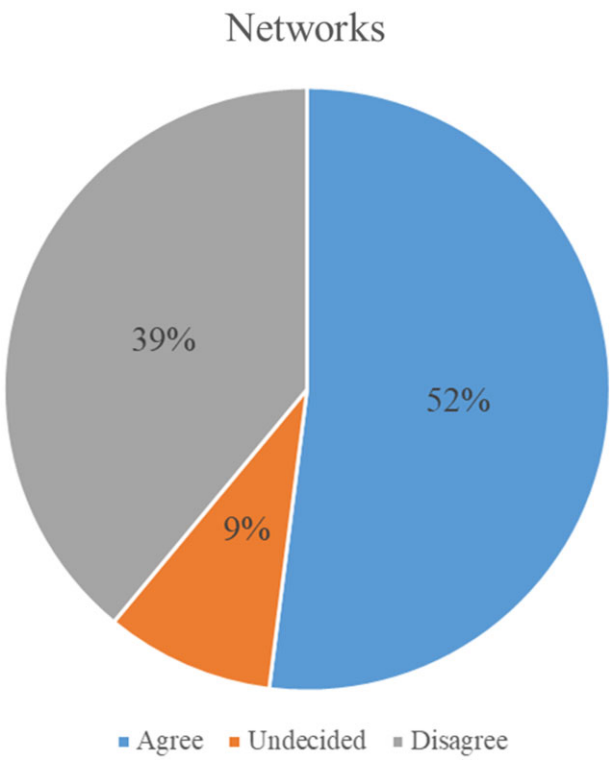

Figure 3. Breakdown of responses to the question of whether lottery procedures prevent existing networks.

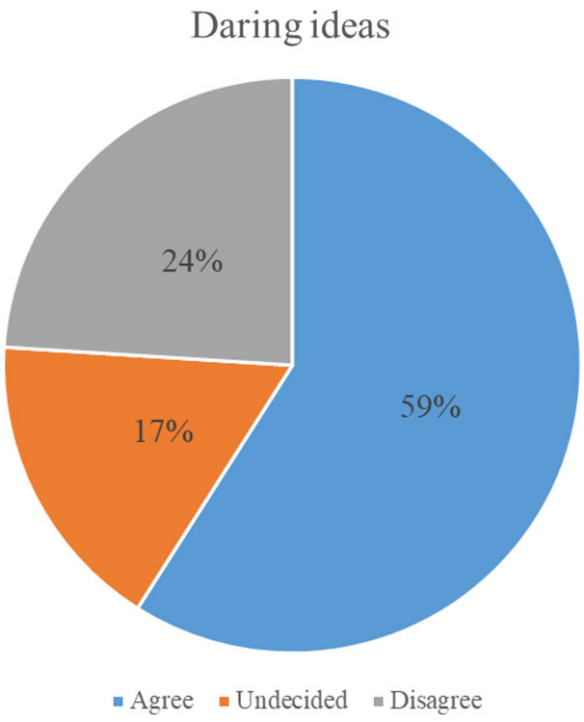

Figure 2. Breakdown of responses to the question of whether lottery procedures offer more opportunity for acceptance of daring ideas than peer review does.

purpose. In the case of legitimate quandaries, which are inherent in peer review processes themselves, alternative solutions would have to be examined because they cannot be resolved by modifications alone. Building on this distinction in the present study, we bring in a second distinction by asking which peer review flaws scholars deem irreparable and which not. Most important, we seek to ascertain the percentage of scientists who regard these shortcomings as one or the other. We are particularly interested in the ones that cannot be corrected, for they prompt thought about making fundamental changes in review processes and can thereby lose their specific quality.

Our results corroborate Barlösius and Philipps' (2022) assumption that randomized selections of research proposals meet with high approval when legitimate quandaries of peer review procedures are encountered. Yet those weaknesses are among the ones considered irremediable in peer review processes. After all, these deficiencies are endemic to the procedures themselves and often force reviewers into poor reasoning (Stone 2009) that brings them to a decision nevertheless.

Interestingly, the case is not clear-cut for illegitimate problems. The assessments of disadvantages due to networks differ seriously from those for early–career and female researchers. A large share of respondents—comparable to that of the respondents who acknowledge the existence of legitimate quandaries in peer review procedures—advocates randomized selections in order to eliminate the influence of networks in review processes. For a sizable majority of respondents, this illegitimate problem is also one of the irremediable flaws in peer review processes. By contrast, there is less agreement among the respondents when it comes to the structural disadvantages confronting early-career researchers and female researchers, and respondents express correspondingly less support for lottery procedures. Apparently, the majority of respondents view structural disadvantages as one of peer review's remediable procedural flaws. These results are ultimately supported by

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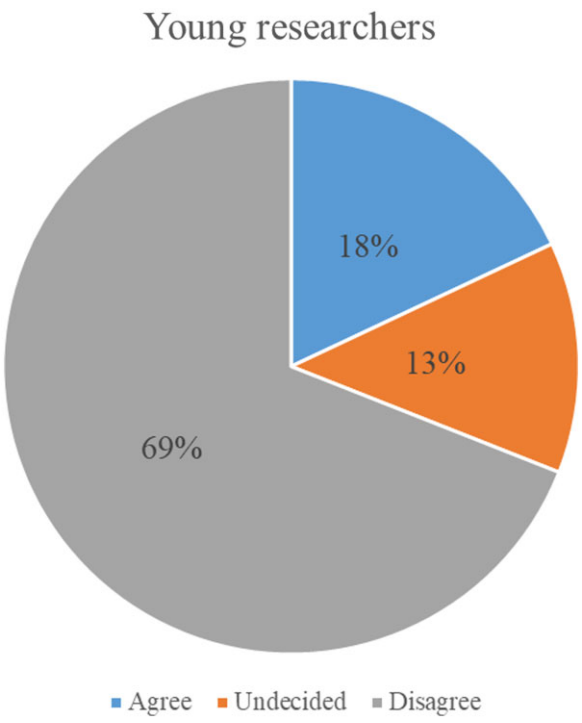

Figure 4. Breakdown of responses to the question of whether lottery procedures offer early-career researchers more opportunities for acceptance of their research proposals than peer review does.

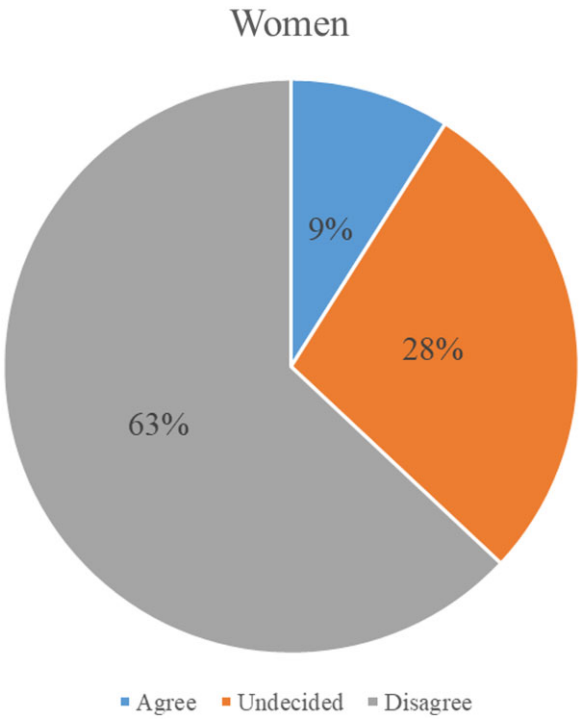

Figure 5. Breakdown of responses to the question of whether lottery procedures offer more opportunities to women than to men for acceptance of their research proposals.

the observation that even researchers who reject randomized selection favour the use of lottery procedures in principle for making a choice when fine differentiation between equally warranted research proposals has reached its limits, for selecting proposals based on daring research ideas, and for breaking through the influence of networks.

The reason why legitimate quandaries of peer review are judged to be irremediable is that they are structural deficiencies of those procedures' specific nature. However, it does not apply to the influence of networks. We propose that it is a problem of practical application or, more precisely, a breach of norms. Agreed and binding selection criteria in the scientific field, such as superior quality or superior suitability, are undermined if norm-breakers favour people who are familiar and committed to them and expect their own advantages from perpetuating network influence on procedures for selecting and funding research proposals. Lottery procedures have countered such norm-breaking to preclude insider relationships in the political field as well without undermining the form of governance (Engelstad 1989). For instance, lots were drawn as a procedure in various European cities in the seventeenth and eighteenth centuries when city councils were torn apart by internal factionalism, delegitimized by family networks, or attacked by the common citizenry. Apparently, many of the interviewees rely on lottery procedures to bring about research-grant allocation that is independent of structures beholden to factions and patronage (Barlösius and Philipps 2022).

By contrast, the structural disadvantage of certain groups of scientists is a problem of justice to the extent that their scholarship is perceived and evaluated unequally. Like other areas of endeavour, the scientific field is oriented to achievement-based equity, which is expressed through reward for outstanding performance and through subsequently enhanced scientific reputation (Merton 1968). The specific nature of randomization, on the other hand, introduces a form of distributive justice (Rawls 1971), which gives everyone an equal chance of winning regardless of merit. Lotteries would thus undermine a central norm of the academic field, a consequence that explains why they are judged unsuitable for alleviating structural disadvantage. Moreover, quotas, special lines of funding, and other procedures are generally available to deal with this illegitimate problem, potentially reducing structural disadvantages while maintaining performance equity. It is possible to test the viability of this interpretation by examining whether similar results can be generated for other structurally disadvantaged groups of scientists, such as those who experience racial or ethnic discrimination.

Another explanation for the assessment that disadvantages of early-career researchers and female researchers count as remediable deficiencies of peer review processes probably arise to some extent from the composition of our sample. More than 70% of the people interviewed were male and 68% were in tenured positions. It is mainly men who are funded in the scientific field (Kaatz et al. 2016), and employees who hold a permanent contract in Germany are presumably older and have already successfully performed scientific work. They benefit from existing practices of peer review and endowment and are less exposed to the pressure of competition for external funding. As with established scientists (Philipps 2022), this group of respondents may be proportionately less likely to reckon with structural disadvantages and may be less open to lottery procedures than early-career researchers and female researchers are. It is possible that a better-balanced sample of respondents would correct our assessments. We assume, however, that it would fundamentally change little about the observation that fine differentiations, the selection of daring

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ideas, and disadvantages due to networks are linked to irredeemable failings of peer review procedures in the scientific field.

Furthermore, our results show that not all respondents value the importance of the investigated problems equally. For example, inexperienced researchers see more severe deficits than experienced researchers do and are more likely to favour lottery procedures. Therefore, there can be no standard solution for improving peer review procedures so that they are perceived as appropriate by all researchers and receive their acceptance equally. In funding programs for female and younger scientists, therefore, particular attention must be paid to the transparency of these procedures.

The present reanalysis of data from a survey of academics on peer review and the use of lottery procedures has three limitations. First, it was not the goal of the survey to examine all of the quandaries and problems of peer review as identified by Barlösius and Philipps (2022). We could only construct countervariables from available variables. For example, some respondents were concerned that their scientific ideas would be stolen during peer review processes. However, they did not bring up lottery processes as a solution in this context. Our chosen approach, therefore, did not allow us to clarify whether this grievance was one of the irremediable flaws of peer review procedures. In principle, the fact that lottery procedures as an alternative are not an issue for some problems of peer review processes allows us to conclude, on the basis of our criteria, that these deficiencies are among the remediable ones. At the very least there is no perceived need to address such deficiencies with non-scientific procedures. Second, the proportion of female respondents in our survey is relatively low. However, the results concerning discrimination of female researchers are sometimes contradictory, especially with regard to the perception reported by these individuals themselves and by others. It would be important to analyse this phenomenon in more depth. Third, the present survey was limited to scientists holding doctorates in Germany, leaving open the question of how scientists in other countries with different scientific systems assess the shortcomings of peer review processes. Lastly, our investigation is confined to possible correlations between the gender of the interviewees and their experience with jury activities linked to awarding grants. Future studies may look into other influences, such as affiliation with particular disciplines or different types of research institutions.

9. Conclusion

In addition to the distinction that Barlösius and Philipps (2022) make between legitimate quandaries and illegitimate problems, our present study has incorporated a second one, that between remediable and irremediable defects. The first distinction derives its specific characteristics from the procedure itself, namely, the scientific field's inherent antagonism between orthodoxy and heresy. It thus arises from peer review as a procedure. The second distinction, between remediable and irremediable, refers to whether scientists can imagine rectifying iniquities in peer review processes through modifications. The second distinction is based much more on the scientists' own practical experience with peer reviews, such as the assessment of proposals they have written or their participation in peer review processes. It is not only about science-specific grievances but also experiences made outside science.

We suggest that both distinctions be taken into account in future research and science policy in order to consider the procedural point of view and to include the practical experiences of scientists. These experiences are not only impressions gained from science but also from general social interaction, which cannot be drawn solely from the scientific procedures and logic of the scientific field. The inclusion of general and, hence, non-scientific social experiences would also help socially contextualize the notion of a special scientific ethos that is still frequently propagated in the scientific field (Merton 1942).

Our observations lead us further to conclude that modifications of peer review processes must take into account that it is a key institution of the scientific field, one in which the field's typical self-image is expressed in a particularly characteristic way. It is necessary not only to continue empirically clarifying how peer review processes are embedded in the scientific field and identifying which changes lead to sustainable improvements but also to deepen this research theoretically. Future research should go beyond the examination of specific review situations and decision-making processes and focus more on the institutional and normative character of peer review processes.

Supplementary data

Supplementary data are available at *Research Evaluation Journal* online.

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Conflict of interest statement. None declared.

Data availability

The datasets generated during and analysed during the current study are available in the FDZ-DZHW repository (Philipps, Barlösius and Johannsen 2024).

Note

1. Bourdieu (1991) also describes such an antagonism for the field of religion, but it has no functional meaning there.

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