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Projectgegevens / Project information

Samenvatting / Summary

To merit society's trust and investment in science, the scientific enterprise has the responsibility to ensure that the science it produces is trustworthy. In order to adequately seize this responsibility, we need to invest in acquiring solid empirical knowledge on which to base evidence-based strategies to counter threats to the trustworthiness of science. One major threat to the trustworthiness of science arises when scientists engage in 'detrimental research practices' (DRPs): behaviors that range from subtle trespasses of ethical and methodological principles to outright scientific fraud. Although the importance of preventing these behaviors is widely recognized, the scope of engagement in DRPs is currently unknown. Estimates of occurrence cannot be validly and reliably based on previous studies because these studies employed methods that did not account for bias due to the sensitivity of admitting to DRPs, employed small samples, or focused on specific scientific disciplines. It is also unclear which strategies should be employed to decrease the occurrence of DRPs. Many initiatives aimed at promoting research integrity exist, but strong empirical evidence on how to actually reduce researchers' engagement in DRPs is lacking. The relatively young body of empirical evidence addressing potential causes and solutions for DRPs provides a promising starting point, but mainly consists of discipline-specific studies that focused on limited sets of variables to explain engagement in DRPs ('explanatory variables'). Moreover, most of these studies did not explicitly address the roles of different stakeholders in the complex science system, nor did their outcomes result in concrete recommendations on how to reduce DRPs.

The National Survey on Research Integrity is a globally unique endeavor in which the Dutch scientific community will take the lead in acquiring the necessary solid empirical basis for building strategies to reduce DRPs and thereby foster Responsible Research Practices (RRPs) in the Netherlands. This project is unique in multiples senses. First, the National Survey takes an approach that acknowledges both the need to take an efficient science-overarching perspective and the need to take into account the differences between scientific disciplines by distinguishing between four major domains of science. Second, it takes an approach that acknowledges the complexity of the science system by addressing the roles of all its five major stakeholders (researchers, academic research institutions, umbrella organizations of these institutes, funders, and publishers). Third, it will

study the largest sample in DRP research to date: the entire population of academic researchers in the Netherlands. Fourth, the National survey will employ highly sophisticated and well-validated Randomized Response (RR) techniques to elicit more honest answers to questions about engagement in DRPs. Fifth, this project will examine the role of a broad range of potential explanatory variables for engagement in DRPs in one single study. This approach will result in 1) valid and reliable science domain-specific estimates of the occurrence of DRPs in the Netherlands, 2) thorough science domain-specific comprehension of which explanatory variables are associated with engagement in DRPs, and 3) shared understanding of the roles that each of the stakeholders in science can play in reducing DRPs.

The knowledge from the National Survey will first be transferred through a comprehensive Open Access publication in a renowned peer reviewed journal and through (inter)national conferences. The results will then be translated into concrete action plans on how to reduce DRPs and thereby foster RRP in the Netherlands, tailored to the five major stakeholder groups and the four domains of science. These action plans will be generated through interactive, solution-focused work sessions with stakeholder representatives from each domain, in collaboration with a professional change implementation organization. The action plans will be disseminated to all stakeholder groups through stakeholder-tailored reports, through further scientific publications, and through the Netherlands Research Integrity Network. The action plans will be discussed at invitational conferences with representatives of stakeholder groups, where further steps to organize the implementation of the action plans will be taken.

The National Survey will be conducted over a period of three years. The first year will be devoted to thorough preparation and extensive piloting of the different aspects of the survey and the RR techniques. The second year will be assigned to data collection, analysis, and reporting. The third year will be dedicated to translation of the survey results into action plans and their dissemination. Across all three years, we will continuously assess and manage risks to the success of the National Survey.

Trefwoorden / Keywords

Responsible Research Practices; Responsible Conduct of Research; Questionable Research Practices; Detrimental Research Practices; Research Integrity; Randomized Response; Scientific Fraud; Research Misconduct

Samenwerking / Collaboration

Samenwerking tussen onderzoek en praktijk / Cooperation between research and practice:

Nee / No

Inhoud / Content

Probleemstelling / Problem definition

Human society is strongly dependent on scientific progress and therefore invests heavily in academic science. Substantial public funds finance the work of academic scientists, who are trusted to achieve significant progress in important societal areas including health, technology, the environment, and socio-economic development [1, 2]. To merit this trust, the academic scientific enterprise has the responsibility to ensure that the results it produces are valid, reliable, and efficient [3]. Especially in a national and international political and societal climate where trust in established authorities is eroding rapidly, and where trust in science in particular has taken substantial blows from high-profile cases of fraud, the urgency of taking responsibility to promote the highest levels of trustworthiness of scientific research is greater than ever.

In order to adequately seize the responsibility for promoting the highest levels of trustworthiness, the scientific enterprise needs to critically self-reflect and invest in acquiring solid empirical knowledge on how to counter threats to the trustworthiness of science. One major threat arises when scientists engage in behaviors that constitute major or minor violations of research integrity. These behaviors range from outright scientific fraud, which is usually defined as fabrication, falsification, and plagiarism (FFP [4, 5]), to more subtle trespasses of ethical and methodological principles that may undermine a study's validity, reproducibility, or efficiency [4-6]. These trespasses, also known as 'questionable research practices' (QRPs, [4, 5], or 'sloppy science' [7]), include behaviors such as deciding not to submit valid, but 'negative' results for publication, failing to report important flaws and limitations of one's study, and selective citing of previous literature to enhance one's own findings or convictions. In the National Survey, the term 'detrimental research practices' (DRPs [8]) is used to define all behaviors that comprise major or minor violations of research integrity.

Although the importance of preventing these behaviors is widely recognized in the Netherlands and abroad, the scope of engagement in DRPs in the Netherlands is currently unknown. Estimates of occurrence cannot be validly and reliably based on previous surveys conducted in other countries because these studies employed methods that did not account for bias due to the sensitivity of admitting to DRPs. The occurrence frequencies yielded by these studies, which range from 2% for fabrication and falsification to over 66% for other DRPs [9-13]), are therefore likely to be underestimations. Moreover, most of these studies used small samples and were highly discipline-specific, limiting their generalizability. It is currently also unclear which strategies should be employed to help scientists conduct their work with the highest levels of integrity. Many initiatives and publications aimed at promoting scientific integrity exist [e.g. 2, 4, 5, 7, 8, 14, 15-22], but strong empirical evidence on how to actually reduce engagement in DRPs is lacking. The relatively young body of empirical studies addressing these questions [11, 23-29] provides a promising starting point, but mainly consists of discipline-specific studies that focused on limited sets of variables to explain engagement in DRPs. Moreover, most of these studies did not explicitly address the separate roles of

different stakeholders in the complex science system, nor did their outcomes result in concrete recommendations on how to reduce DRPs.

In order to acquire the necessary solid empirical knowledge on which to build evidence-based strategies to reduce DRPs, the complexity of the scientific system should be taken into account. Academic scientists conduct their research in the context of their immediate research environment of their institute (including collaborators, principal investigators, heads of departments, deans, and executive boards) and the environment of their individual discipline and wider science domain. At the same time, scientists operate in the context of the broader science system, including funding agencies, journals, and publishers. Therefore, rather than aiming for the development of narrow discipline-specific knowledge or for the development of a single comprehensive theory that can be applied to explain the behavior of all scientists in all scientific disciplines and all contexts, a more balanced approach is needed. This balanced approach should consider the role and interplay of all major stakeholders in the Dutch science system, take into account the differences between scientific disciplines, and at the same time acknowledge the need to be efficient and take a more overarching perspective.

Relevantie / Relevance

Fostering responsible research practices (RRPs) has been particularly high on the agenda in the Netherlands since the discovery of a number of high-profile scientific fraud cases at Dutch academic institutions and the worrying reports describing a culture of 'sloppy science' issued after these cases [7, 30]. Since these events, many initiatives aimed at fostering RRP have been taken. For example, the 'Science in Transition' initiative urges for fundamental reform, particularly with respect to the performance criteria that are used to evaluate scientists [14]. In 2014, the Dutch Ministry of Education, Culture, and Science issued the '2025 Vision for Science - choices for the future' in which strategies for dealing with urgent challenges in science were discussed. Here, various chapters were devoted to systemic changes including lowering of publication and funding pressures on researchers. In 2015, the 'Leiden Manifesto for research metrics' was published [15], warning about the adverse effects of the widely used metrics that were designed with the aim to increase the quality of research. Early in 2017, the National Plan Open Science was released [31] advocating a systemic change towards open collaboration, open publication and dissemination, and open sharing of resources and data [16]. Currently the Dutch code of conduct for scientific practice is undergoing revisions that reflect an increased recognition of the importance of the whole spectrum of major and minor research misbehaviors [18], following recent revisions of the European [17], Australian [20], and Danish codes of conduct of scientific practice [19].

All these initiatives will contribute to increasing the trustworthiness of scientific research in the Netherlands, but none of them are truly evidence-based. The National Survey on Research Integrity is a globally unique endeavor in which the Dutch scientific community will take the lead in acquiring the necessary solid empirical knowledge on which to build evidence-based strategies to reduce DRPs in the Netherlands and abroad. It is unique in multiples senses. First, the National Survey takes a balanced, science-wide approach that takes into account the differences between scientific disciplines by explicitly distinguishing between four major domains of science that encompass all disciplines in the Netherlands: a) the Life Sciences and Medical Sciences; b) the Natural Sciences and Engineering Sciences; c) the Humanities, Language, Information, Communication, Law, and Arts; and d) the Social Sciences and Behavioral Sciences. Second, it addresses the roles of the five major stakeholder groups in the science system: a) researchers, b) academic research institutions, c) umbrella organizations of academic research institutes, d) funders of academic research, and e) publishers of academic research (see Figure 1 in Appendix 1). Third, the National Survey will study the largest sample in DRP research to date as it will approach the entire population of academic researchers in the Netherlands. Fourth, the National survey will employ highly sophisticated and well-validated Randomized Response techniques to elicit more honest answers to sensitive questions about engagement in DRPs. Fifth, the National Survey will examine the role of a wide range of potential explanatory variables for engagement in DRPs in one single study. This approach will result in a) valid and reliable domain-specific estimates of the occurrence of DRPs in the Netherlands, b) thorough domain-specific comprehension of which explanatory variables play a role in DRPs at the level of the individual researcher, the research culture in which the researcher is operating, and the science system in which the researcher works and c) shared understanding of the roles that each of the stakeholders in science can play in reducing DRPs. This knowledge will be translated into concrete action plans for all major stakeholders on how to help reduce DRPs and thereby foster responsible research practices (RRPs), increasing the trustworthiness, and ultimately also the societal relevance of science.

Kennisoverdracht, implementatie, bestendiging / Knowledge transfer, Implementation Consolidation

The knowledge acquired through the National Survey will consist of a) valid and reliable domain-specific estimates of the occurrence of DRPs in the Netherlands, b) thorough domain-specific comprehension of how which explanatory variables are associated with engagement in DRPs, and c) shared understanding of the roles that each of the stakeholders in science can play in reducing DRPs and fostering RRP. This knowledge will then be translated into concrete action plans tailored to the five major stakeholder groups in the science system: the researchers, the academic research institutions, the umbrella organizations of academic research institutes, the funders of academic research, and the publishers of academic research. These stakeholders will already be contacted and involved during the preparatory year of the project.

The action plans will be generated through nine interactive, solution-focused work sessions with stakeholder representatives that will be conducted in collaboration with a professional change implementation organization. First, a series of five work sessions by stakeholder group will be held, with representatives from the four different domains of science participating together (see Figure 1 in Appendix 1). Purpose of these sessions is to identify stakeholder-specific opportunities for effective actions with respect to those aspects in the system that were identified as risk factors for DRPs. Next, another series of four work sessions by science domain will be conducted with representatives from the five stakeholder groups working together. Here, the participants will build on the results of the previous sessions to align the proposed actions from each stakeholder group and compile an integrated action plan that includes actions that are domain-overarching, and actions that pertain to each individual science domain. Finally, a summary of the survey results and the action plans will be compiled into five short reports

(one report for each stakeholder group). These reports will contain five chapters each: one chapter with a domain-overarching action plan, and four chapters with a domain-specific action plan.

In order to maximize the value of the National Survey, the knowledge acquired in the National Survey will be disseminated to all relevant national and international stakeholders in academic science. First, the quantitative results from the National Survey will be made available to all stakeholders through a comprehensive Open Access publication in a renowned peer-reviewed journal and will be presented at conferences in the field of research integrity. This publication will also be disseminated to the executive boards of the academic research institutions, to the umbrella organizations of the academic research institutions, to national and international science funding organizations and foundations, and major science publishers. In addition, the publication will be circulated through the Netherlands Research Integrity Network (www.nrin.nl) and will be shared with concurrent national and international projects aimed at fostering responsible conduct of research, including five Horizon 2020 projects, the Academic Research Culture Amsterdam (ARCA) project, and the other projects in the Dutch National Program on Fostering Responsible Research Practices.

In the next phase, the reports containing the action plans for each stakeholder group will be made public through the Netherlands Research Integrity Network (NRIN) and the relevant report will be sent to each individual stakeholder group. In addition, the action plans will be outlined in five further publications in renowned peer-reviewed Open Access journals: one major paper in an interdisciplinary journal summarizing the five reports, and four papers in domain-specific journals summarizing the domain-specific chapters from each stakeholder-tailored report. Furthermore, an invitational conference for representatives of all stakeholder groups will be organized together with the researchers involved in the 'Life Cycle Project', also funded by ('pillar 3' of) the National Program on Fostering Responsible Research Practices. Here, a joint program will be created in which the findings and recommendations from the two projects will be presented and discussed. To support the implementation of the action plans generated through National Survey, another invitational conference for representatives from the five stakeholder groups will be held where further steps to organize the realization of the action plans will be taken. Additional international dissemination of the knowledge obtained in the National Survey will occur through the international 'Mapping Normative Frameworks for EThics and Integrity of Research' (EnTIRE) platform that is currently being developed in an ongoing Horizon 2020 project coordinated by VU University Medical Center, and through presentations at international conferences like the 6th World Conference on Research Integrity.

Doelstelling / Objective

The objective of the National Survey on Research Integrity is to make a significant contribution to the acquisition of solid empirical knowledge on which to build evidence-based strategies to reduce DRPs and thereby foster RRP in the Netherlands. In doing so, it aspires to be conducive of increasing the trustworthiness, and ultimately the societal value of science. In its strategy to fulfill this objective, the National Survey takes an approach that acknowledges both the need to take an efficient science-overarching perspective and the need to take into account the differences between scientific disciplines. It therefore chooses to distinguish between four major domains of science that encompass all disciplines in the Netherlands: a) the Life Sciences and Medical Sciences; b) the Natural Sciences and Engineering Sciences; c) the Humanities, Language, Information, Communication, Law, and Arts; and d) the Social Sciences and Behavioral Sciences. Moreover, the National Survey takes an approach that acknowledges the complexity of the science system. It therefore addresses the roles of all of the five major stakeholder groups in the science system: a) researchers, b) academic research institutions, c) the umbrella organizations of these institutions, d) funders of academic research, and e) publishers of academic research. Figure 1 in appendix 1 depicts this approach.

Within this approach, the National Survey seeks to obtain a) valid and reliable domain-specific estimates of the occurrence of DRPs in the Netherlands, b) thorough domain-specific comprehension of which explanatory variables are associated with engagement in DRPs, and c) domain-overarching and domain-specific shared understanding of the roles that each of the stakeholders in science can play in reducing DRPs and fostering RRP. To obtain this knowledge, the National Survey aims to study the largest sample in DRP research to date: the entire population of academic researchers in the Netherlands. In addition, it will employ sophisticated Randomized Response techniques to elicit more honest answers to questions about engagement in DRPs. Finally, the National Survey will examine the role of a broad range of potential explanatory variables for engagement in DRPs in one single study. Employing extensive stakeholder consultation, the obtained knowledge will then be translated into concrete stakeholder tailored action plans on how to reduce DRPs and thereby foster responsible research practices (RRPs).

Plan van Aanpak / Strategy

To describe how we warrant the adequate and efficient execution of the National Survey, we present our research strategy in ten sections. Before we outline each section in detail, we will first further define the most important terms that we use, and provide a brief overview of the ten sections.

DEFINITION OF TERMS

Academic Researchers

For the National Survey, we define academic researchers as all people who are employed as Professor, Associate Professor, Assistant Professor, post-doctoral researcher, or PhD student at a Dutch University or Dutch University Medical Center (UMC) and who engage in scientific research for at least 8 hours per week. The category 'PhD student' consists of two sub-categories: 'internal' PhD students (employed by the university or UMC), and 'external' PhD students (employed by another organization, retired, or non-employed, but supervised or co-supervised by a promotor from a university and planning to receive their PhD

from this university). We do not include researchers from other research organizations or research units for two reasons: a) we deem it infeasible and impractical to include all scientific researchers in the Netherlands, b) there are large differences between academic research and non-academic research. With the National Survey we aim to focus solely on academic researchers working in academic research institutes.

Detrimental Research Practices

For the National Survey, we use the term 'detrimental research practices (DRPs)' to denote all major and minor misbehaviors by academic researchers that to some extent violate scientific integrity. These behaviors encompass practices that are classified as fraud (fabrication, falsification, and plagiarism (FFP), and practices that constitute more subtle trespasses of ethical and methodological principles that undermine a study's validity, reproducibility, or efficiency [4-6]. Such trespasses are also known as 'questionable research practices' (QRPs, or 'sloppy science' [7]. With this definition, we follow the recently issued report 'Fostering Integrity in Research', released by National Academies of Sciences, Engineering, and Medicine in April 2017 [8]. The selection of DRPs to be included in the National Survey will occur through an extensive process based on a) a list of 60 research misbehaviors that was composed by consulting the world's leading experts in the field of research integrity, b) the Academic Research Culture Amsterdam (ARCA) study (www.amsterdamresearchclimate.nl) that investigates which of these 60 behaviors are considered most important in different science domains, and c) focus groups with representatives from each of the science domains.

Explanatory Variables

We employ the term 'explanatory variables' for the constructs that we measure in order to 'explain' engagement in DRPs. Rather than implying causality, which is impossible to determine in a cross-sectional design, we study the correlations between these explanatory variables and engagement in DRPs. The term 'explanatory variables' is used in other research examining detrimental behavior [32, 33], and includes all of the many variations of this term used in different fields (e.g. predictors, determinants, independent variables and correlates).

Science Domains

The National Survey takes an approach that acknowledges both the need to take an efficient science-overarching perspective and the need to take into account the differences between scientific disciplines by distinguishing between the major domains of science. Many categorizations of scientific disciplines can be and also are used. In the National Survey, we employ a categorization of scientific disciplines into four major science domains: a) the Life Sciences and Medical Sciences, b) the Natural Sciences and Engineering Sciences, c) the Humanities, Language, Information, Communication, Law, and Arts, and d) the Social Sciences and Behavioral Sciences. This categorization is based on a combination of the classification employed by The Netherlands Observatory of Science and Technology (NOWT) and the classification employed by Web of Science (WoS): the so called NOWT-WoS classification. This classification categorizes science into seven domains and lists all disciplines falling in each domain (see http://www.cwts.nl/pdf/howt_classification_sc.pdf). We chose to leave out the seventh domain ('multidisciplinary') and to group the remaining six domains into four domains because of the sizes of the samples per domain that are required for the National Survey. The full list of disciplines under these categories can be found through the link above. In the National Survey, respondents will be asked to indicate the domain in which they (predominantly) work through a dropdown menu containing the four domains and a list of all disciplines falling under that domain.

Randomized Response

Despite assurances of anonymity and confidentiality, surveys can be subject to problems associated with social desirability, particularly when sensitive questions are involved [34, 35]. Obtaining valid and reliable estimates of detrimental behavior is therefore difficult. A well-validated method to reduce the effect of social desirability is the Randomized Response (RR) technique [36, 37]. This technique protects respondents against potential ramifications of admitting to detrimental behaviors by the creation of a probabilistic rather than a direct association between the answer given by the respondent and the behavior of the respondent.

OVERVIEW OF STRATEGY

With the National Survey, we seek to obtain a) valid and reliable domain-specific estimates of the occurrence of DRPs in the Netherlands, b) thorough domain-specific comprehension of the associations between explanatory variables and engagement in DRPs, and c) domain-overarching and domain-specific shared understanding of the roles that each of the stakeholders in science can play in reducing DRPs and fostering RRP. We will pursue the first two of these objectives by surveying all scientific personnel employed for research at all universities and university medical centers in the Netherlands through a web-based questionnaire. In this questionnaire, we will first pose a set of well-validated and extensively piloted questions measuring the explanatory variables. These questions will be followed by a set of five domain-specific DRPs. For each practice, respondents are asked to indicate whether they have ever engaged in it, and whether they have engaged in it at least once during the last three years. To elicit more honest responses to the questions about engagement in DRPs and to guarantee anonymity, we will apply a highly advanced Randomized Response (RR) technique. We will pursue the third objective through extensive stakeholder consultation in which the obtained knowledge will be translated into concrete stakeholder-tailored action plans on how to reduce DRPs and thereby foster responsible research practices (RRPs) across and within each of the four science domains. This stakeholder consultation will occur in collaboration with a professional change implementation organization.

We will describe our research strategy in ten sections. These sections will be executed during the project that will have a total duration of three years, as outlined in Figure 2 in Appendix 1. In the first year, we will thoroughly prepare the execution of the survey: we will prepare the recruitment of respondents (section I); select the DRPs to include in the survey (section II); tailor and pilot the Randomized Response techniques to be applied in the survey (section III); adapt, tailor and pilot the measurements of explanatory variables (section IV); and prepare our data analysis plan and our data management protocol in which we define how we securely store and archive our data and take all necessary measures to protect the confidentiality of the data and the identity of respondents and institutions (section V). In the second year, we will conduct the actual survey: we will collect the data with the help of a trusted, professional data collection organization (section VI); analyze the data, and report the quantitative results in a manuscript to be submitted for Open Access publication in a renowned, peer-reviewed journal and at (inter)national conferences (section VII). The third year will be devoted to transferring and implementing the knowledge obtained in survey: we will employ extensive stakeholder consultation in order to translate the survey results into concrete action plans to reduce DRPs (section VIII); write reports and further scientific publications to transfer the obtained knowledge and actions plans to all relevant stakeholders, organize invitational conferences to take further steps to implement the action plans, and discuss the actions plans at (inter)national conferences (section IX). Across all three years, we will thoroughly assess and manage risks to the success of the National Survey (section X).

I. PREPARATION OF RECRUITMENT OF RESPONDENTS

Based on a combination of sources including annual reports of the UMCs and summaries of university and UMC personnel data issued by the umbrella organizations of the universities and the UMCs we estimate the population of academic researchers in the Netherlands to consist of roughly 30,000 persons, half of whom are internal PhD students. We are not yet able to estimate the size of the group of external PhD students because they are not regularly registered and not distinguished from internal PhD students in the annual counts of PhD defenses listed in the annual reports of the institutions. During the preparation of the survey, we will obtain precise population sizes for each group and assess the feasibility of including external PhD students.

In order to maximize the statistical power required to fully benefit from the Randomized Response technique that will be used, we will target the entire population of academic researchers as described above. As earlier web-based surveys about DRPs among scientists reported response rates between 24% and 65% [11-13, 28, 38-40], it is difficult to provide a precise response rate estimation. Taking into account the possibility of obtaining the lowest response rate of 24%, we need to target the full population in order to be able to precisely estimate the occurrence of DRPs within the four domains of science and to examine the relationships between the explanatory variables and the DRPs within each domain. Another reason to target the entire population is that in order to keep the survey response time short (under 15 minutes) to get an optimal response rate, we will employ so-called 'missingness by design' for the measurements of the explanatory variables. This means that each respondent will be presented with only a random sub-set of explanatory variables.

With the aim to reach all eligible respondents, maximize response rates, and maximizing privacy and confidentiality, we will recruit our respondents in the following way:

- a. We will seek the collaboration of the executive boards of all Dutch universities and UMCs to provide us with the email addresses of their scientific personnel. We will make clear that we will not collect nor be able to identify data at the level of institutions, departments, and individuals. We will compose written data transfer agreements in which we lay down our commitments to the privacy of the institutions and respondents.
- b. We will seek collaboration with the umbrella organizations of the universities (VSNU) and the UMCs (NFU) and ask for their active support of the National Survey.
- c. We will seek collaboration with the rectors of all universities and the deans of all UMCs and ask them to announce and recommend the survey to all scientific personnel, supporting this with in-company communication.
- d. We will seek contact with some respected science journalists in the Netherlands before we execute the survey, emphasizing our focus on the improvement of the quality of science and explaining the mechanism of Randomized Response and the potential consequences of incorrect interpretation of the results following from its use (e.g. concluding that occurrence of DRPs is higher in the Netherlands than in other countries while these other studies did not use this technique and may thus have elicited fewer honest answers).
- e. We will announce the survey through university and UMC internal media outlets, such as institutional and faculty newsletters and magazines.
- f. All invited researchers will be provided with access to our privacy policy. This privacy policy describes how we comply with all requirements of the General Data Protection Regulation (GDPR) Act, by which Ethics Committees the study protocols will have been reviewed, and a statement declaring that the study does not fall under the scope of the Medical Research Involving Human Subjects Act (WMO). The privacy policy will further explain that data set will not contain any personal data other than in which of the four major science domain the respondent works, their gender, and whether they are PhD student, non-tenured scientist, or tenured scientist. Individuals are thus neither directly nor indirectly identifiable. In addition, it will specify how and under which restricted circumstances the data may be shared for verification or further analyses with third parties (see Strategy Section VI), how we will prevent data breaches, and how we ensure that only authorized persons can access the anonymous data set (see also Strategy Section VI). Finally, it will specify how and where we will disseminate the results. All invited researchers will also have access to the full study protocol.

g. Invitees who decide to participate will be presented with a digital consent form. This form will briefly repeat a number of items described in the privacy policy, followed by information stating that they are free to withdraw at any time during the survey. They will also be informed that because the URL that is based on their e-mail address will be removed automatically as soon as all questions have been completed and the answers have been recorded, it is not possible to delete the data of individual respondents afterwards upon request. Respondents indicate their consent by ticking a box in the digital form.

h. A trusted, professional data collection organization (see Strategy Section V) will execute the survey. This organization will send a message to all e-mail addresses containing an invitation to participate in the survey, a brief explanation of the goal of the study, the privacy policy, and the link to the survey itself. When respondents click on this link, they will first be directed to the informed consent form, and then to the survey itself. In the invitation e-mail, participants will also be offered a link they can use to opt out from the survey and any future e-mails about the survey. The trusted data collection organization executing the survey will send up to three (weekly) reminders to invitees who haven't responded but haven't opted out either.

During the preparation of this proposal, the project leader (Prof. dr. L. Bouter) has discussed the plans for National Survey in the Dutch Rectors Conference. The rectors reacted positively to the plans, but voiced some concerns about potential damage to the reputation of Dutch science in general and their institutions in particular. We were able to reduce these concerns and establish trust through our guarantee that our data collection will not include the collection of any identifying information from respondents or institutions: data will be collected and analyzed only at the level of the science domain in which the researcher works. The only other personal data that will be collected are gender (m/f/no answer), and academic rank (tenured / non-tenured / PhD student (external vs internal)). The reason that we will not obtain data on institute and department is that we believe that the costs of potential damage to the reputation of institutes and departments outweigh the benefits of obtaining personal data that allows for adequate analyses of non-response patterns. In order to enable limited non-response analysis, we will ask respondents who choose to opt out of the survey to answer four short questions in which they indicate their gender, their academic position, their science domain, and their main reason for not responding. Prior to the start of the project, we will submit our research protocol to the Institutional Review Board of the VU University Medical Center (VUmc) to obtain a statement that the National Survey is not classified as Medical Research ('niet-WMO verklaring', compulsory for all non-medical research at VUmc). Our protocol will also be submitted to the Ethics Committee of the Faculty of Behavioural and Movement Science of the Vrije Universiteit Amsterdam, and the Faculty of Social and Behavioral Sciences of Tilburg University.

II. SELECTION OF DRPS TO INCLUDE IN THE SURVEY

Each respondent will be presented with five sets of two questions about their own engagement in DRPs. For each of five DRPs, they will be asked 'Have you ever [...]?' and 'Have you, in the last three years, [...]?'. They will be instructed to answer these questions using a digital version of Randomized Response (RR, see Strategy Section III). There are a number of reasons to choose for five behaviors. First, RR has only been used and validated with a limited number of behaviors in one questionnaire. Developments to expand its use to more behaviors are ongoing, but to obtain the best estimates, we have been advised by world leading experts on RR, Prof. Dr. P. van der Heijden and Dr. M. Cruyff, to limit the number of behaviors to five. With two questions about each behavior, this amounts to 10 questions about DRPs. Second, limiting the number of DRPs enables us to better focus the development of concrete action plans (see section IX). Third, we need to keep the survey response time short (under 15 minutes) to get an optimal response rate. Answering 10 questions using RR will take approximately 5 minutes, which leaves only 10 minutes for questions related to our explanatory variables (see Strategy Section IV).

Of the five DRPs, one will be domain-overarching, and four will be domain-specific. The domain-overarching DRP will be a DRP that falls under the traditional scientific fraud or research misconduct category (Fabrication, Falsification, and Plagiarism or FFP): fabrication of research results. Fabrication has a major impact on public trust in science and scientists, but we currently do not have a reliable estimate of the extent of the problem. While the same is true for falsification and plagiarism, these terms are ambiguously defined and may in many cases not fall under the fraud category [e.g. 41]. Plagiarism does not directly affect the validity and reliability of research results, but is a major concern in some domains of science and might therefore be selected as one of the domain-specific DRPs (see next paragraph). To reliably estimate the occurrence of a behavior that is expected to occur very rarely, which is the case for fabrication (previously estimated to occur at 2% [9]), a very large sample size is needed. A sufficiently large sample size can only be obtained with enough certainty if we present the question about fabrication to all respondents from all domains. Furthermore, even though fabrication may be a more relevant DRP in some domains than in others, we consider examining the sensitive topic of the occurrence of fabrication in some domains and not in others indefensible.

To select domain-specific DRPs we will engage in an extensive process. In this process, we will focus on a list of 60 research misbehaviors that was composed by consulting the world's leading experts in the field of research integrity [42]. The 60 misbehaviors were ranked in different ways, among which perceived frequency of occurrence, impact on truth finding, impact on trust among scientists, and the products between frequency and the different forms of impact. Although this work thus provides an indication of which DRPs are most relevant, the list is primarily focused on the biomedical sciences. To consider the perspective of researchers from the four domain of science on the 60 misbehaviors, we will collaborate with and learn from the concurrent Academic Research Culture Amsterdam (ARCA) study (www.amsterdamresearchclimate.nl), which is also using this list. This study, which is currently being executed by our Steering Committee group member Dr. J. Tjink, includes a survey among all researchers at the four Amsterdam academic institutes (University of Amsterdam, Vrije Universiteit Amsterdam, Amsterdam Medical Center, and VU University Medical Center), in which respondents are asked to rate the 60 behaviors in the same manner as the experts did in Bouter et al., but then at the level of their own science domain. In addition, this study will include focus groups with scientists from the four major science domains, in which participants will discuss which research practices are most problematic in their domain. During the first, preparatory year of the National Survey, we will

consult with the researchers involved in this study, and participate in conducting the focus groups. This consultation and collaboration will provide the basis for the selection of domain-specific DRPs in each domain for the National Survey.

The ARCA project will yield a top ten ranking of DRPs per domain. We will feed the 10 DRPs from these rankings into four focus groups with researchers from each domain to discuss these top tens of DRPs, to reflect on whether important DRPs are missing, and to determine which four DRPs in each domain should finally be included in the National Survey. Next, we will conduct a similar focus group among the members of the Steering Committee, who will each participate taking the perspective from their own domain of science. To render the focus group discussions more efficient, we will send each group member the top ten DRPs in their domain in advance, and ask them to tick the four that they believe should be included in the National Survey and to think of DRPs that are missing. For the preparation of the focus groups, three experts who have extensive experience with conducting focus groups about research integrity with scientists have shared their protocols with us and have committed to provide consultancy and guidance. These experts are Prof. Dr. M. Anderson, Dr. B. Martinson, and Prof. Dr. R. de Vries [e.g. see 25]. Finally, we will also consult with the researchers involved in the 'Life Cycle project', funded by Pillar 3 of the national program 'Fostering Responsible Research Practices', who will employ different methods to examine which DRPs are relevant in which domain.

III. TAILORING AND PILOTING OF RANDOMIZED RESPONSE TECHNIQUE TO BE APPLIED IN THE SURVEY

Despite assurances of anonymity and confidentiality, surveys can be subject to problems associated with social desirability, particularly when sensitive questions are involved [34, 35]. Obtaining valid and reliable estimates of detrimental behavior is therefore difficult. A well validated method to reduce the effect of social desirability is the Randomized Response (RR) technique [36, 37]. This technique protects respondents against potential ramifications of admitting to detrimental behaviors by the creation of a probabilistic rather than a direct association between the answer given by the respondent and the behavior of the respondent.

The basic principle of RR is the following: a randomization device determines to which one of two statements a respondent is asked to respond truthfully: either to a sensitive statement (e.g. 'I have committed social welfare fraud'), or to its complement ('I have not committed social welfare fraud'). For example, if a throw of two dice is used, the respondent is asked to respond to the first statement when the total number of eyes thrown lies between 2 and 9, but to respond the second statement if the total number of eyes lies between 10 and 12. Since the outcome of the dice throw is known only to the respondent, it remains unknown to which of the statements the respondent's answer applies. Because the probability of answering the sensitive statement is known to be 5/6 (the probability of throwing 2 to 9), and probability of answering its complement is known to be 1/6 (the probability of throwing 10 to 12), it is possible to correct for the error induced by the randomization, and to obtain a prevalence estimate of welfare fraud. RR techniques ensure that individual answers are protected by design and have consistently proven to yield more valid estimates than more direct questioning techniques by eliciting more honest responses, especially as the sensitivity of the question increases.

In the National Survey, we will employ an adaptation of the RR that is known as the 'Kuk method', which is characterized by the use of innocuous answers. The original Kuk design uses two decks of cards; a "yes" deck with 80% red cards and 20% blue cards, and a "no" deck with 20% red cards and 80% blue cards. The respondent is instructed to draw a card from each deck, and to report the color of the card from the deck that corresponds to the respondent's answer to the sensitive question. The benefit of this design is that reporting the color of a card is less threatening to the respondent than answering yes or no. Multiple variations of the Kuk method have been used successfully and using the Kuk method has been shown to increase respondents' trust in the RR method, especially when respondents are highly educated [43]. Another adaption from the original RR method that we will employ is the use of two questions for each detrimental behavior. Rather than only asking whether the respondent has ever engaged in a specific behavior, we will also ask whether the respondent has engaged in that specific behavior in the last three years. Using this method, we will obtain for each DRP estimates of the percentages of academic researchers who a) do not engage in the DRP, b) formerly engaged in the DRP, and c) currently engage in the DRP. The 'two-question design' was recently used in a study examining use of performance-enhancing drugs among professional athletes and was found to be up to four times more efficient than a 'one-question design' in terms of sample size [44]. Sophisticated statistical models have been developed that allow multivariate analysis and the inclusion of covariates in prevalence estimates [44-50]. These models enable us to obtain the percentages listed above, but also to analyze which explanatory variables are most strongly associated with current and former engagement in DRPs. In these models, we will also be able to correct for non-compliance with the RR instructions.

There are some potential concerns with the use of RR that we will address. First, RR is statistically less efficient than direct questioning, especially when the occurrence of the detrimental behavior is low. The large sample size of the National Survey, however, allows RR to yield reliable estimates, even if the occurrence of a particular DRP is low. In addition, we employ the use of the 'two-question design' described in the previous paragraph in order to increase the efficiency of the RR technique. Figure 4 in Appendix 1 depicts the statistical power to estimate the occurrences of DRPs with a population occurrence frequency of 2%, which is the previous mean estimate for the DRP that is thought to be the rarest DRP: 'fabrication' [9], and those with a population occurrence frequency of 9%, which is the previous mean estimate for DRPs that do not fall in the FFP category [9]. This figure shows that approximately 1500 respondents are needed for a power of 80% to estimate the occurrence of fabrication with the bivariate model (i.e. the model using the 'two-question design'). We would already reach this number at a response rate of 5%. Figure 4 also shows that only 100 respondents are needed for a power of over 80% to estimate the occurrence of DRPs that occur at a frequency of 9% with the bivariate model. We would reach these numbers in all domains even if the smallest domain would consist of a population of 1000 of which only 10% responded. A second concern about the use of RR might be that it seems too complicated for respondents to use. However, RR has been successfully used in populations with rather low educational attainment [51]. As respondents in the National Survey are highly-educated,

complicatedness should not be a problem. Moreover, the RR technique in the survey will be introduced with an explanation and two practice-questions. During the preparatory year of the National Survey, we will extensively pilot the described version of the RR technique among a representative sample of scientists working in another country.

IV. ADAPTATION, TAILORING AND PILOTING OF THE MEASUREMENTS OF EXPLANATORY VARIABLES

To explain researchers' reasons to employ DRPs, a very wide range of theories can be applied. Each of these theories suggests different 'explanatory variables'. Theories that have been employed in this context range from theories of natural selection to personality theories [28, 52]. In order to make a well-founded selection of explanatory variables to include in the National Survey, we employed three criteria: a) Which explanatory variables have so far received strong support? b) Which explanatory variables do the world's leading experts on research integrity consider most important? c) Which explanatory variables can be influenced by policies or interventions?

Below, we address the 13 explanatory variables that meet each of these three criteria, and list their associated construct and operationalization. Before we list these explanatory variables, it is important to note three points. First, we will extensively pilot and validate all scales that need adaptation from the original version and scales that need to be constructed in a sample of academic researchers in a European country with a science system that is similar to the Dutch science system. Piloting and validation will consist of assessment of the psychometric properties of the scales and of cognitive interviews with pilot participants filling out the survey. Second, to keep response times under 15 minutes while at the same time being able to include a wide variety of explanatory variables we will employ so-called 'missingness by design'. This means that each respondent will be presented with only a random sub-set of measurements taken from the full set of explanatory variables. From each of the five groups of explanatory variables listed below, respondents will only be asked to answer the items relating to one explanatory variable. Fourth, although these explanatory variables each operate at different levels (at the level of the individual, at the level of the direct research environment, or at the level of the science system, we will only be able to measure each of the explanatory variables at the level of the perception of the individual researcher.

A schematic overview of the explanatory variables is provided in Figure 3 in Appendix 1. This figure also depicts how the explanatory variables are categorized as either operating at the level of the individual, at the level of the direct research environment, or at the level of the science system. The direction of the expected associations with engagement in DRPs is depicted with '-' or '+', and the colors refer to the five groups of explanatory variables listed below.

Selection of explanatory variables:

Group 1. In the last two decades, rather strong support has been reported for explanatory variables derived from Focus Theory of Normative Conduct [38, 53]. This theory assumes that two sets of norms play a role in people's behavior choices: 'injunctive norms' and 'descriptive norms'. Injunctive norms reflect how people are supposed to behave, while descriptive norms reflect how people actually behave. When these norms are in conflict, people tend to behave in line with descriptive norms. In research culture, this translates to researchers perceiving descriptive norms that are not in line with the injunctive norms of science [54], leading them to behave in line with these descriptive norms rather than with the injunctive norms. For example, when the injunctive norm is that one should submit valid, but 'negative' results for publication, but the descriptive norm is that no one in one's research group or one's science domain does that, the two types of norms are in conflict. When they are in conflict, scientists will tend to behave in line with the descriptive norms, and thus not submit valid, but 'negative' results for publication. The explanatory variables following from this framework are:

- 1) Own scientific norm subscription. Existing scale [38].
- 2) Perceived scientific norm adherence of colleagues at the level of one's research group. Existing scale [38], but the questions need to be adapted to pertain to colleagues in one's research group rather than to one's 'typical colleague'.
- 3) Perceived scientific norm adherence of colleagues at the level of one's science domain. Existing scale [38], but the questions need to be adapted to pertain to colleagues in one's science domain rather than to one's 'typical colleague'.

Group 2. At the same time, strong support has also been reported for variables derived from Organizational Justice Theory [26, 27, 55]. This theory postulates that when people regard the distribution of resources within an organization or system (and the decision process underlying that distribution) as unfair, they may engage in certain behaviors to compensate for the perceived unfairness. In science, this translates to the idea that researchers who perceive for example the allocation of science funding as unfair may selectively cite previous literature in grant applications to enhance their own findings or convictions. The explanatory variables following this framework are:

- 4) Perceived effects of organizational injustice at the level of one's university or UMC. Subscales from existing scales [26, 27, 56].
- 5) Perceived effects of organizational injustice at the level of the science system. Subscales from existing scales [26, 27, 56], but the questions need to be adapted to pertain to the science system rather than to one's institution.

Group 3. Another set of variables that meet all three criteria is related to pressures that scientists experience and/or perceive. For example, scientists may feel that in order to publish enough to keep their job, they should not fully report important flaws and limitations of their study in their manuscripts. Multiple studies demonstrate that these kinds of pressures are believed to

play a major role in the occurrence of DRPs [11, 24, 25, 38, 57, 58], but empirical evidence for associations with DRPs is limited [29]. These variables translate into the following explanatory variables to be included and measured in the National Survey:

- 6) Perceived competition. Existing scale [38, 57], but the questions need to be adapted to include items that pertain to one's research group and items that pertain to one's scientific domain.
- 7) Perceived work pressure (in terms of working hours, flexibility, home and family pressures, etc.). Existing scale [38, 57] that needs to be validated.
- 8) Pressure resulting from dependence on obtaining external funding. Scale to be constructed.

Group 4. The next set of variables is related to the daily social environment: mentoring and social support. Mentoring has been found to be able to operate in two directions. Whereas mentoring focused on survival in science (e.g. encouraging strategies to publish efficiently through dividing the results of one study over many different publications) has been found to be associated with a higher likelihood of engaging in DRPs, mentoring focused on responsible conduct of research has been found to be associated with a lower likelihood of engaging in DRPs [23]. The extent to which researchers feel emotionally supported by their colleagues and supervisors has also been found to be associated with a lower likelihood of engaging in DRPs [23, 38, 57]. These variables translate into the following explanatory variables to be included and measured in the National Survey:

- 9) Extent of mentoring focused on survival in science received. Scale exists [23] but needs revision and validation.
- 10) Extent of mentoring focused on responsible conduct of science received. Scale exists [23] but needs revision and validation.
- 11) Perceived social support. Existing scale [38, 57], but needs validation.

Group 5. Finally, there is an explanatory variable set for which empirical support for associations with detrimental behavior in general exists, but that has not yet been investigated in the context of research behavior. Research on regulatory noncompliance, where explanatory variables for behaviors such as social security fraud and use of performance-enhancing drugs in sports have been studied [32, 44], provided support for the idea that the perceived risk of detection plays a major role in these types of behaviors. For instance, in science, researchers working with data may be less likely to properly archive their data if archiving regulations are not enforced. This translates into the following explanatory variables to be included and measured in the National Survey:

- 12) Likelihood of detection of DRPs by colleagues, supervisors, and peers. A tested framework to measure perceived risks of non-compliant behavior exists [32, 44, 59], and needs to be adapted to apply to risks of engaging in DRPs.
- 13) Likelihood of detection of DRPs by reviewers or legal authorities. A tested framework to measure perceived risks of non-compliant behavior exists [32, 44, 59], and needs to be adapted to apply to risks of engaging in DRPs.

V. PREPARATION OF DATA MANAGEMENT PROTOCOL

Right at the start of the first year of the National Survey, we will develop a complete data management plan according to the requirements of the Netherlands Organization for Health Research and Development (ZonMw). We will do this in collaboration with data management and privacy protection expert of the VUmc, M. Paardekooper and the Steering Committee's legal expert Mr. dr. C. Ploem. The data management plan will include descriptions of the general features of the project and data collection, of how we comply with privacy laws and regulations, of how we will store and archive the data, and in which ways, under which conditions, and with whom we will share the data.

It is important to note that the data we collect through the National Survey will feature 'Privacy by Design'. First, the RR techniques that will be used to measure self-admitted engagement in DRPs (see section III) renders it impossible to link individual true answers to individual respondents because the associations between the answers given by the respondent and the behavior of the respondent are probabilistic rather than direct. The outcomes of the randomization device cannot and will not be recorded. Second, the only personal data in the data set will be the respondents' gender, their academic position (PhD student internal / PhD student external / non-tenured scientists / tenured scientist), and their science domain: a) the Life Sciences and Medical Sciences, b) the Natural Sciences and Engineering Sciences, c) the Humanities, Language, Information, Communication, Law, and Arts, and d) the Social Sciences and Behavioral Sciences. As each combination of these variable is associated with very large groups, it will be impossible to directly or indirectly identify individuals. Finally, the list of e-mail addresses that is used to create the personal URLs to the survey (needed to monitor response and avoid duplicate responses) will be destroyed directly after the launch of the survey. The URLs themselves will not appear in the dataset.

VI. DATA COLLECTION

In order to achieve the highest levels of quality in our data collection procedure, we will outsource the data collection of the survey itself to an experienced, trusted, and highly respected panel research organization in the Netherlands. This organization will work according to information security norms ISO 27001, 27002, and NEN 7510, and fall under European and Dutch data protection laws. An attorney from the Innovation Exchange Amsterdam (IXA) (see <http://www.ixa.nl/en/home.html>) will compose a processing agreement with the selected organization following a standard format.

The specific order that we will negotiate with various eligible organizations constitutes the following:

- Professional programming of the questionnaire
- Building in the randomized response mechanism while ensuring that this mechanism does not record the outcomes of the randomization device
- Building in an 'opt out' option, leading to four short questions about gender, academic position, science domain, and reason for non-response
- Extensive testing of the questionnaire and the data collection logistics
- Sending invitations to 30,000 – 40,000 potential respondents through e-mail (e-mail addresses provided by National Survey research group, see section I)
- Recording bouncing e-mail addresses and reasons for bouncing
- Monitoring response
- Sending weekly reminders to invitees who have not responded or opted out (max. 3)
- Providing help desk support for respondents
- Collecting and storing the data on a protected server in the Netherlands
- Automatic immediate removal from the recorded data of the personal URLs used by respondents to access the survey
- Delivering the data file in csv format
- Ensuring strict confidentiality

Based on preliminary quotations from a number of highly professional organizations the costs of this service will not exceed € 25.000 excluding tax. To be able to choose the organization that will deliver the highest quality and highest levels of confidentiality and to account for 21% tax we reserve € 30,250 of the research budget for the survey data collection.

VII. ANALYSIS OF THE SURVEY DATA AND REPORTING OF THE SURVEY RESULTS

ANALYSIS OF THE SURVEY DATA

We will analyze the National Survey data with the help of highly qualified and experienced data analysts and statisticians including some of the world's leading experts on Randomized Response (Prof. dr. P. van der Heijden and Dr. M. Cruyff). During the first year of the project, we will develop a detailed analysis plan with this group and preregister it (together with the complete research protocol) at the Open Science Framework (www.osf.io).

With the analysis of the survey data, we aim to attain the first two objectives of the National Survey: to provide a) valid and reliable domain-specific estimates of the occurrence of DRPs in the Netherlands and b) thorough domain-specific comprehension of which explanatory variables are associated with engagement in DRPs. Below, we briefly list the analyses that will be conducted to reach each of these two objectives.

a. Valid and reliable domain-specific estimates of the occurrence of DRPs in the Netherlands:

- i. Multinomial models per DRP and per domain, combining the questions 'have you ever [...]?' and 'have you in the last three years [...]?'. These result in efficient estimates of 'no engagement in the DRP', 'former engagement in the DRP' and 'current engagement in the DRP'.
- ii. A log-linear model with five variables for the five DRPs (each consisting of three categories: 'no engagement in the DRP', 'former engagement in the DRP' and 'current engagement in the DRP'), for each domain separately. This results in efficient estimates of the associations between DRPs within each domain.

b. Thorough domain-specific comprehension of how which explanatory variables are associated with engagement in DRPs:

- i. Multinomial regression models with per DRP and per domain, combining the questions 'have you ever [...]?' and 'have you in the last three years [...]?', and including explanatory variables as covariates. This yields sets of the most strongly associated explanatory variables per domain.
- ii. An IRT model with all five DRPs per domain. This model assumes that each DRP can be ordered in terms of severity [10], and gives an indication of the likelihood of engaging in DRPs given the scores on the covariates (i.e. the explanatory variables).

REPORTING OF THE SURVEY RESULTS

The knowledge acquired in the National Survey will be disseminated to all relevant national and international stakeholders in academic science, as well as to other researchers in the field of research integrity (also called 'meta-research'). First, the quantitative results from the National Survey will be made available to all stakeholders through a comprehensive Open Access publication in a renowned peer-reviewed journal and will be presented at conferences in the fields of research integrity and meta-research. In addition, we will promote dissemination of the results through sharing of the publication with the executive boards of the academic research institutions, the umbrella organizations of the academic research institutions, national and international science funding organizations and foundations, and national and international science publishers. In addition, the publication will be circulated through the Netherlands Research Integrity Network and will be shared with concurrent national

and international projects aimed at fostering responsible conduct of research, including five Horizon 2020 projects (PRINTEGER, ENERI, EnTIRE, DEFORM, en UPSCALE), the Academic Research Culture Amsterdam (ARCA) project, and the other projects in the Dutch National Program on Fostering Responsible Research Practices.

VIII. EMPLOYMENT OF EXTENSIVE STAKEHOLDER CONSULTATION IN ORDER TO TRANSLATE THE SURVEY RESULTS INTO CONCRETE ACTION PLANS

After submitting the quantitative results of the National Survey for publication in the second year, the third year will be employed to knowledge transfer and implementation through the translation of the survey results into action plans and their dissemination. Here, we describe how the survey results will be translated into concrete action plans to reduce DRPs. The action plans will be tailored to the five major stakeholder groups in the science system: the researchers, the academic research institutions, the umbrella organizations of academic research institutes, the funders of academic research, and publishers of academic research.

The action plans will be generated through nine interactive, solution-focused work sessions with stakeholder representatives that will be conducted in collaboration with professional change implementation organization P2 (www.p2.nl). At this organization, implementation- and project change manager Dr. S. Zuijdgheest has extensive experience with transformation projects amongst scientists, is knowledgeable about the scientific stakeholder landscape, and is committed to help strengthening research practices both inside and outside academia.

First, a series of five work sessions by stakeholder group will be held, with representatives from the four different domains of science participating together (see Figure 1 in Appendix 1). Prior to the work sessions, the representatives of the stakeholder groups will receive a summary of the results of the National Survey. Purpose of the sessions is to identify stakeholder-specific opportunities for effective actions with respect to those aspects in the system that were identified by the survey as risk factors for DRPs. The five work sessions will be conducted with the following groups:

- a) Researchers (from each of the four domains a PhD student, a non-tenured scientist, and a tenured scientist) (n = 12).
- b) Representatives of the various stakeholders within institutes: (four Deans representing the four domains, four heads of departments representing four domains, and four tenured scientists representing four domains) (n = 12).
- c) Representatives (chairs or vice-chairs) from the two large umbrella organizations (one from VSNU, one from NFU), four rectors, and four deans representing four domains (n = 10).
- d) Representatives (adjunct-)directors or (vice-)chairs from funding organizations: (one from the Ministry of Education, Culture and Science, one from each of the governmental funding organizations (NWO, ZonMw, and ERC), one from each of three science funding foundations, and one from each of three science funding industries (n = 10).
- e) Representatives from science publishers: Editors-in-chief from major scientific journals (at least two from each domain), and representatives from at least two major scientific publishing companies (n = 12).

Next, another series of four work sessions by science domain will be conducted with representatives from the five stakeholder groups working together. Here, the participants will build on the results of the previous sessions to align the proposed actions from each stakeholder group and compile an integrated action plan that includes actions that are domain-overarching, and actions that pertain to each individual science domain. These four work sessions will each be conducted with the following group members: one PhD student, one non-tenured scientist, one tenured scientist, one head of department, one dean, one rector, one representative of each of the two umbrella organizations VSNU and NFU, one from each of the governmental funding organizations (NWO, ZonMw, and ERC), one from a science funding foundation/ fund, and one from a science funding industry (n = 13).

Based on a preliminary quotation from the professional project- & change management organization P2, the costs of collaborating with this organization in the manner described above would amount to a maximum of €48,400 including tax. This includes thorough preparation, conducting nine half-day sessions, and conversion of the work session results into written action plans. These action plans will be constructed and formulated in a 'SMART' manner: Specific, Measurable, Agreed upon, Realistic and Time-based (see <https://www.projectsmart.co.uk/smart-goals.php>).

IX. FURTHER KNOWLEDGE TRANSFER, IMPLEMENTATION, AND CONSOLIDATION

After the work sessions, a summary of the survey results and the action plans will be compiled into five short reports (one report for each stakeholder group). These reports will contain five chapters: one chapter with a domain-overarching action plan, and four chapters with a domain-specific action plan. The reports containing the action plans for each stakeholder group will be made public through the Netherlands Research Integrity Network website and the relevant report will be e-mailed to leading members of each individual stakeholder group. In addition, the action plans will be outlined in five further Open Access publications in renowned peer-reviewed journals: one major paper in an interdisciplinary journal summarizing the five reports, and four papers in domain-specific journals summarizing the domain-specific chapters from each stakeholder-tailored report. Furthermore, an invitational conference for representatives of all stakeholder groups will be organized, together with the researchers involved in the 'Life Cycle Project', also funded by ('pillar 3' of) the National Program on Fostering Responsible Research Practices. Here, we would like to create a joint program in which the findings and recommendations from the two

projects will be presented and discussed. Additional international dissemination of the knowledge obtained in the National Survey will occur through the international 'Mapping Normative Frameworks for EThics and Integrity of Research' (EnTIRE) platform that is currently being developed, and through presentations at international conferences such as the 6th World Conference on Research Integrity. To further encourage the implementation and consolidation of the action plans informed by the National Survey, another invitational conference for representatives from the five stakeholder groups will be held where further steps to organize the implementation of the action plans will be taken.

X. RISK ASSESSMENT AND MANAGEMENT

There are several potential threats to the success of the National Survey that need to be addressed. Below we list the most important risks, and how we aim to address them.

One major risk we see is that the results of the National Survey may be (mis)used to undermine the authority of science and public trust in science. The aim of the National Survey is for science to take the responsibility to critically evaluate itself and investigate how it can improve its quality and increase its value. Self-assessment is a risky endeavor, because the inevitable evidence of needs for improvement can be interpreted as evidence of untrustworthiness or incompetence. In the current political and societal climate where trust in established authorities erodes rapidly, an initiative that should (re)gain societal trust and public support for in science may backfire and be misused to achieve the opposite. This risk is further increased by potential misinterpretation of estimates of the frequency of occurrence of detrimental research practices based on the use of Randomized Response techniques: if the National Survey yields higher estimates than studies in other countries that did not use Randomized Response techniques, the incorrect conclusion that more researchers in the Netherlands engage in detrimental research practices than in other countries is easily made.

This risk is strongly dependent on media coverage. Although we have no control over how the media will report on the National Survey, we will take initiatives to clearly convey the intentions of the National Survey, and to clearly explain the Randomized Response method on the Open Science Framework and through making available URLs to information about RR through the website of the Netherlands Research Integrity Network. Before the survey takes place, we will contact a limited number of highly respected science journalists from the Netherlands and abroad, and inform them about the objectives and the methods of the National Survey. When our manuscript reporting the main results has been accepted for publication and the journal's embargo period has passed, we will share our results with the selected journalists again. In interviews we will elucidate the major findings and voice concerns about potential misinterpretation. In addition to our own communication with science journalists, we will keep in close contact with the communication officers of each of the institutions to tune the messages institutions convey about the forthcoming survey and the results of the survey. Finally, we will be seeking professional advice from an experienced science communication expert, who can help us communicate with different types of media. Another media-related risk lies in social media. Discussions in Facebook groups and on Twitter about the forthcoming or ongoing survey may affect researchers' willingness to respond, or even influence their responses to the survey questions. The topic of research integrity is already trending on social media, and news about a nationwide study that is to survey every Dutch researcher on misconduct as reported in Times Higher Education last year [60], may fuel discussions even more. For this reason, we will closely monitor social media coverage of the National Survey before, during, and after its execution.

A second, more practical risk, lies in the institutions' potential refusal to share the e-mail addresses of their scientific personnel with us. However, we believe that we can reduce this risk by investing heavily in convincing the executive boards of the importance of the National Survey and by guaranteeing absolute anonymity of the respondents and institutions. We can guarantee this anonymity because we have chosen to prioritize the protection of the identity of the institutions over the importance of being able to analyze non-response patterns. The data that we will collect will not include any variables that can lead to direct or indirect identification of institutions, nor of respondents. The project leader (Prof. dr. L. Bouter), who is the former Rector Magnificus of the Vrije Universiteit Amsterdam, will regularly communicate with the rectors of the Dutch universities and the deans of the university medical centers (UMCs). At earlier meetings, he has discussed the plans for the National Survey several times and has already been able to establish substantive levels of trust and interest with respect to the National Survey. In addition, we are collaborating with the ARCA Project Team (see Strategy Section I), whose members are currently learning about the issues involved with obtaining the e-mail addresses of scientific personnel from the academic institutes and with conducting a web-based survey among a large group of academic scientists. They will share their experiences and advice with us, and help us connect to different parties involved in the practical and legal aspects of sharing the e-mail addresses.

A final risk lies in researchers' unwillingness to respond, because low response rates and selection bias negatively affect the quality and the representativeness of the data. To increase response rates, we will invest heavily in encouraging potential respondents to participate in various ways. As mentioned in section I, we will ask the university rectors, the UMC deans, and their umbrella organizations to actively support the National Survey. In addition, we will ensure coverage in the institutes' and faculties' newsletters, and provide extensive information through the website of the Netherlands Research Integrity Network (including information about Randomized Response and how this protects respondents). The invitation to the survey will contain elaborate information about the objectives of the survey, about the manner in which privacy and confidentiality is guaranteed, and about what happens to the collected data. During the execution of the survey itself, respondents will have continuous access to an online and a telephone help desk that will be able to answer all their questions about the survey. During the preparation of the survey we will collaborate intensively with non-response and web-survey expert and Steering Committee member Prof. dr. J. Bethlehem. Together, these strategies will contribute to increasing the response rate and decreasing response bias. In order to enable limited non-response analysis, we will ask respondents who choose to opt out of the survey to answer four short questions in which they indicate their gender, their academic position, their science domain,

and their main reason for not responding.

In order to closely monitor the execution of the complete project, the steering group of the National Survey will convene when specific milestones are about to be reached. These milestones include a) the results of the pilot being available, b) the survey being ready for launch, c) the preliminary results being available, d) the first comprehensive manuscript being ready for submission, and e) the actions plan being ready to be presented in reports.

Expertise, voorgaande activiteiten en producten / Expertise, prior activities and products

Project Team:

Prof. dr. L.M. Bouter is Professor of Methodology and Integrity at VU University Medical Center (VUmc) and Vrije Universiteit Amsterdam (VU), is specialized in research on RRP's and DRPs, and is organizer and co-chair of the 5th World Conference on Research Integrity, Amsterdam, May 2017. Being the former Rector Magnificus of the Vrije Universiteit Amsterdam, Prof. Dr. Lex. M. Bouter has an extensive network that is highly relevant for the successful execution of the National Survey. He is the founding chair of the Netherlands Research Integrity Network (www.nrin.nl). <http://www.abrahamkuypercenter.nl/bouter/> and <https://sites.google.com/site/lexbouter/home>.

C. L. S. Veldkamp (MSc) is specialized in research methodology, statistics and research integrity, is currently finalizing her PhD dissertation on 'the human fallibility of scientists' at the department of Methodology and Statistics of the School of Social and Behavioral Sciences at Tilburg University, and is part of the Meta-research Center at Tilburg University (www.metaresearch.nl). <https://www.tilburguniversity.edu/webwijs/show/c.l.s.veldkamp/>.

Dr. G. ter Riet is Associate Professor and PI in clinical epidemiological methods at Academic Medical Center (AMC), and is specialized in research on research integrity and secretary of the committee that drafted the Research Program 'Fostering Responsible Research Practices'. <https://www.amc.nl/web/Research/Who-is-Who-in-Research/Who-is-Who-inResearch.htm?p=367>.

Prof. dr. J. M. Wicherts is professor in methodology of the social and behavioral sciences at the Tilburg School of Social and Behavioral Sciences at Tilburg University, is specialized in research methods and research integrity, founder of the Metaresearch Center at Tilburg University (www.metaresearch.nl), and an affiliate member of the Meta-Research Innovation Center at Stanford (METRICS). He recently obtained a prestigious €2M ERC Consolidator Grant to continue his efforts to improve scientific methods. <https://www.tilburguniversity.edu/webwijs/show/j.m.wicherts.htm>.

Prof. dr. P. G. M. van der Heijden is Professor of Statistics for the Behavioral and Social Sciences at the Faculty of Social and Behavioral Sciences, Universiteit Utrecht, Chair of the Ethical Review Board and the Committee for Scientific Integrity of his faculty, and is considered one of the world's leading experts on Randomized Response Techniques and estimating fraud prevalence. <http://www.uu.nl/staff/PGMvanderHeijden/0>.

Dr. M. J. L. F. Cruyff is Assistant Professor of Statistics for the Behavioral and Social Sciences at the Faculty of Social and Behavioral Sciences, Universiteit Utrecht, and is specialized in Randomized Response. www.uu.nl/staff/mcruyff.

Steering Committee:

Prof. dr. G. Widdershoven is professor of Philosophy and Ethics of Medicine and head of the Department of Medical Humanities at VUmc, is specialized in qualitative research, is involved in national and international projects on empirical ethics, and recently received a €4M Horizon 2020 grant to pursue the project Mapping Normative Frameworks for Ethics and Integrity of Research (EnTIRE). <http://www.emgo.nl/team/1030/guywiddershoven/personal-information/>.

Prof. dr. H. J. Paul is Associate Professor of Historical Theory at Leiden University, Professor Extraordinarius in Secularization Studies at the University of Groningen, and is currently leading a project on character features, personality traits, and virtues contributing to good scholarly performance. <https://www.universiteitleiden.nl/en/staffmembers/herman-paul>.

Prof. dr. B. van der Meulen is Head of Research at the Rathenau Instituut, The Hague, professor of Evidence for Science Policy at Leiden University, and is specialized in science policy and in research on the dynamics of science and science policy. <https://www.rathenau.nl/en/medewerkers/prof-dr-barend-van-der-meulen>.

Dr. I. A.L. Stoop is Senior Scientific Staff member at the Netherlands Institute for Social Research (SCP) and is specialized in non-response. https://www.scp.nl/english/Organisation/Staff/Stoop_Ineke.

Prof. dr. J. G. Bethlehem is Emeritus Professor in Survey Methodology at Leiden University, formerly senior methodological advisor at Statistics Netherlands, and specialized in web-survey methodology and non-response. <https://www.universiteitleiden.nl/en/staffmembers/jelkebethlehem>.

Dr. J. Tjink is postdoctoral researcher at Vrije Universiteit Amsterdam (VU), and is specialized in research on research culture and DRPs. <http://www.abrahamkuypercenter.nl/dr-joeri-tjink/>.

Dr. P. Y. W. Dankers is Associate Professor in the Institute for Complex Molecular Systems (ICMS) and the department of Biomedical Engineering, in the Laboratory of Chemical Biology and the Laboratory for Cell and Tissue Engineering, at the Eindhoven University of Technology (TU/e), and member of the KNAW committee 'Replication Studies'. www.dankerslab.nl.

Dr. S. Zuidgeest is Implementation- and project change manager at professional project and change management organization P2, and is specialized in Business Transformation, Project Management, Program Management, and Change Management. <http://www.p2.nl/mensen/sonja-zuidgeest/>.

Mr. dr. C. Ploem is an experienced expert and teacher in the field of health law, in particular on the topic of privacy protection and the legal aspects of data research, and is a member of the Dutch Health Council and various medical ethics committees (IRBs). <https://www.amc.nl/web/Research/Who-is-Who-in-Research/Who-is-Who-in-Research.htm?p=874>.

International collaborators:

Prof. dr. M. S. Anderson is professor of higher education at the University of Minnesota, USA, is Chair of the Committee on Scientific Freedom and Responsibility of the American Association for the Advancement of Science, and is editorial board member of the journals Science and Engineering Ethics, the Journal of Empirical Research on Human Research Ethics, Research Integrity and Peer Review, and Accountability in Research. She was Co-chair of the Third and Fourth World Conferences on Research Integrity, and is a pioneer in research on research integrity. <http://www.cehd.umn.edu/olpd/people/faculty/M-anderson.asp>.

Dr. B. C. Martinson is Senior Research Investigator at HealthPartners Institute, Research scientist at the Minneapolis VA Center for Chronic Disease Outcomes Research and Associate Professor of Medicine at the University of Minnesota, USA. He is a pioneer in research on research integrity and its relationship to the structural organization of science, and developer of several survey instruments to evaluate research environments. <https://www.healthpartners.com/hprf/investigators/martinson.html>.

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Appendix 1.

Fig. 1. The science system as projected in the National Survey on Research Integrity

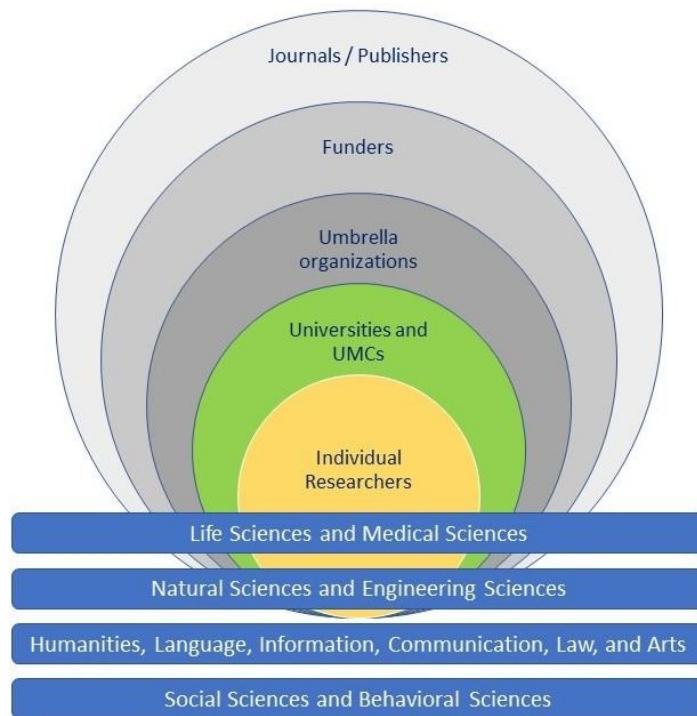


Fig. 2. Project planning National Survey on Research Integrity across months

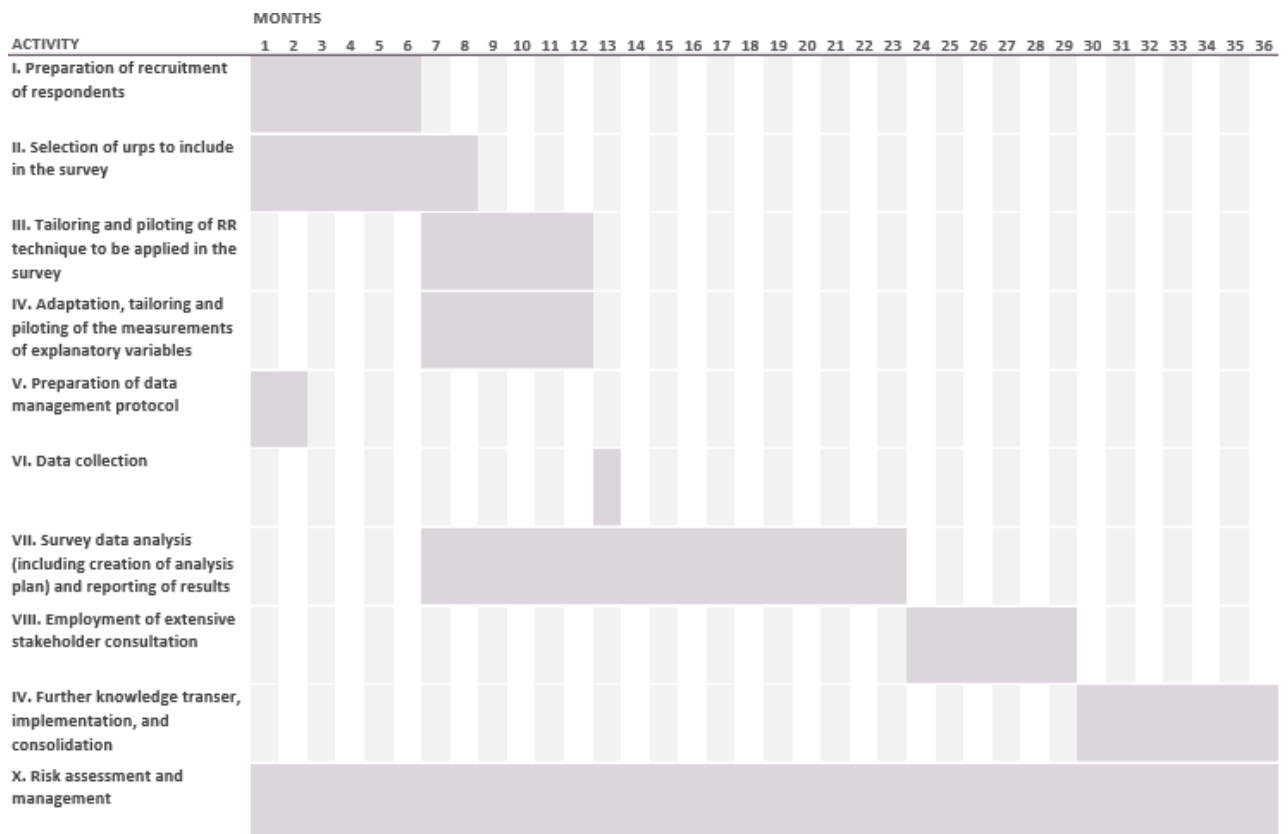
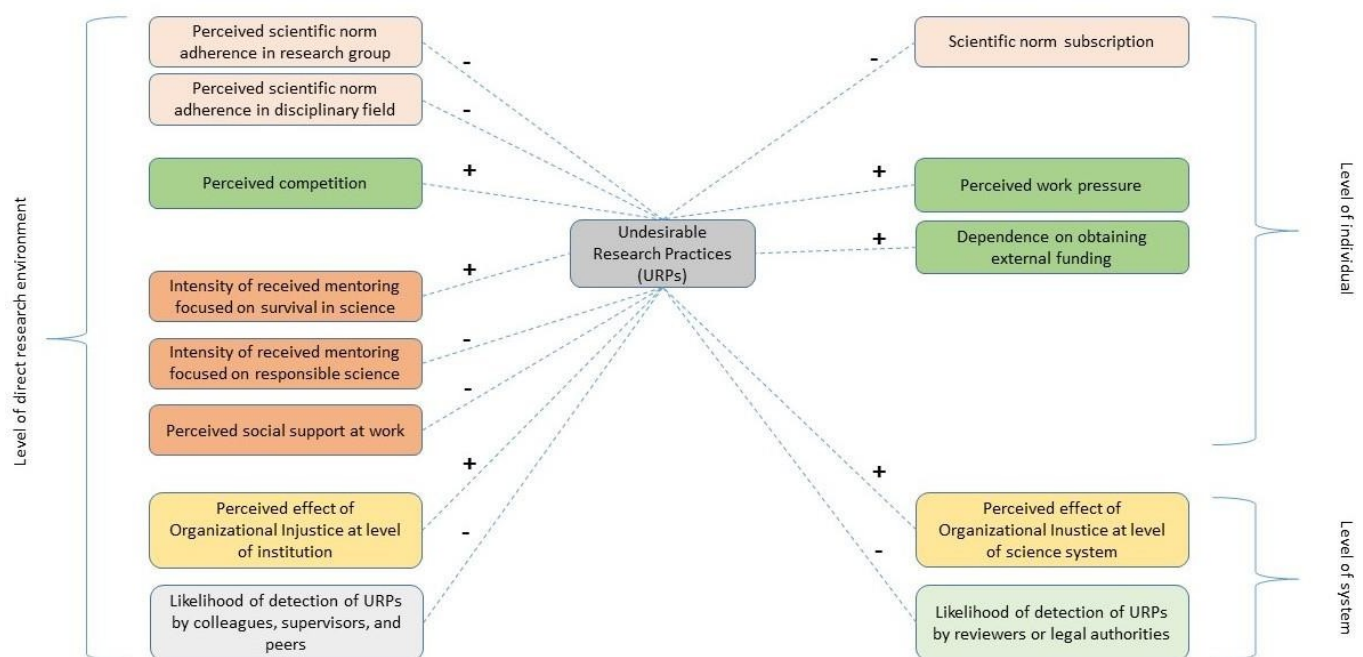


Figure 3. Overview of explanatory variables operating at different levels.



Note. Colors represent the five groups of explanatory variables: Pink = group 1, yellow = group 2, green = group 3, orange = group 4, and light grey = group 5. A '+' indicates a positive association between the explanatory variable and URPs, while a '-' indicates a negative association with URPs.

Figure 4. Statistical power using the 'two-question design' (bivariate) versus the 'one-question design' (univariate), for URPs with population occurrence frequencies (prevalence) of 2% and 9%.

