Taylor & Francis
Taylor & Francis Group

Accountability in Research
Policies and Quality Assurance

ISSN: 0898-9621 (Print) 1545-5815 (Online) Journal homepage: https://www.tandfonline.com/loi/gacr20

Academic research integrity: Exploring researchers' perceptions of responsibilities and enablers

Twan Huybers, Bronwyn Greene & Detlef H. Rohr

To cite this article: Twan Huybers, Bronwyn Greene & Detlef H. Rohr (2020): Academic research integrity: Exploring researchers' perceptions of responsibilities and enablers, Accountability in Research, DOI: 10.1080/08989621.2020.1732824

To link to this article: https://doi.org/10.1080/08989621.2020.1732824

Accepted author version posted online: 19 Feb 2020.
Published online: 03 Mar 2020.

ACCOUNTABILITY IN RESEARCH, 2020
https://doi.org/10.1080/08989621.2020.1732824

Taylor & Francis
Taylor & Francis Group

Academic research integrity: Exploring researchers' perceptions of responsibilities and enablers

Twan Huybers[a], Bronwyn Greene[b], and Detlef H. Rohr[c]

[a]School of Business, UNSW – Canberra, Australia; [b]Division of Academic Conduct & Integrity, UNSW – Sydney, Australia; [c]Division of Research, UNSW – Sydney, Australia

ABSTRACT

In this paper, we explore academic researchers' perceptions of the relative importance of the individual responsibilities in the "Singapore Statement on Research Integrity". The way researchers view those responsibilities affects the role that research integrity enablers can play in achieving responsible research conduct. Hence, we also explore researchers' perceptions of five such integrity enablers in this paper: country and university codes of conduct, staff training, mentoring and peer pressure.

Using data from a global online survey of university researchers (n = 302), a Best-Worst Scaling approach was used to elicit researchers' priorities in different scenarios of responsibilities. In conjunction with latent class analysis, this yielded the implied relative importance of each researcher responsibility. For three of the four homogeneous classes of researchers identified, a different responsibility dominated the hierarchy. For instance, STEM researchers gave precedence to research methods over all other responsibilities. In relation to researchers' perceptions on the effects of research integrity enablers, our results identified research mentoring relationships and normative peer pressure as important integrity conduits. Further exploration showed that researchers differed in their perceptions on enablers, particularly by academic position, duration of employment and country of employment. Based on our exploratory study, we identify several avenues for further research.

KEYWORDS

Research integrity; responsible conduct of research; researcher responsibilities; integrity enablers; Singapore Statement

1. Introduction

During the second World Conference on Research Integrity in Singapore in 2010, the "Singapore Statement on Research Integrity" was developed (Resnik and Shamoo 2011; Kaminskii 2012). Its purpose is to provide a "global guide to the responsible conduct of research" (Singapore Statement on Research Integrity 2010). The preamble introduces the global principles and professional responsibilities that are deemed fundamental to the responsible conduct of research. There are four principles in the "Singapore Statement on Research Integrity" ("Singapore Statement" hereafter) as the overall foundations for such conduct: honesty in all aspects of research; accountability in the conduct of research;

CONTACT Twan Huybers t.huybers@adfa.edu.au School of Business, UNSW – Canberra, Australia

professional courtesy and fairness in working with others; and good stewardship of research on behalf of others. These are broadly mirrored in Shaw and Satalkar's (2018) study of scientists' interpretation of research integrity which finds that the notion of truth is perceived as the key feature of integrity, comprising honesty, objectivity and transparency.

The Singapore Statement comprises 14 professional responsibilities. Two of these are relevant at the level of research organizations; they address the responses to irresponsible research practices and the creation of integrity-supporting research environments. The remaining responsibilities relate to individual researchers. The Singapore Statement lists these in a non-alphabetical order although it is not clear whether any particular order is implied.

The suitability of the broad structure of the Singapore Statement, by way of principles and responsibilities, is acknowledged in recently developed research codes of conduct in Australia (Australian Code for the Responsible Conduct of Research 2018) and The Netherlands (Netherlands Code of Conduct for Research Integrity 2018) – both published during the timeframe of the study reported here. The Dutch code includes several principles, a series of "standards for good research practice" (mostly by stage in the research process) and "institutions' duties of care". Similarly, the new Australian Code of Conduct comprises a list of "principles of responsible research conduct" followed by a list of responsibilities of institutions and of researchers.

Against the background of a quote attributed to CW Lewis, "Integrity is doing the right thing, even when no one is watching", integrity and ethics in higher education have been expressed in similar terms (Couch and Dodd 2005; Fanelli, Ioannidis, and Goodman 2018; Hosseini et al. 2018). As such, doing the right thing is broadly reflected in the researcher responsibilities above. However, it is not clear whether researchers view those responsibilities as "equally right". Instead, researchers may prioritize certain obligations over others in their research practices. Knowledge of such patterns of relative importance is pertinent with a view to fostering research integrity. For instance, if researchers perceive certain responsibilities as less important than others, there may be a case for research management intervention by universities. As Bouter (2015, 155) observes, it is vital to know researchers' views "so that policies and educational content can be modified accordingly."

In the above context, we investigated two research questions. The first research question "Is there is a hierarchy of researcher responsibilities as perceived by academic researchers?" was the first aim of our study. We used the individual researcher responsibilities contained in the Singapore Statement as they may be considered universal in nature (Anderson et al. 2013). To capture any differentiation between responsibilities, we adopted the Best-Worst Scaling (BWS) approach as will be discussed below. As part of this research question, we investigated heterogeneity in academic researchers' views by identifying homogenous groups of researchers. If

(groups of) researchers hold views about (certain) research integrity responsibilities that are not conducive to responsible research conduct, research management intervention may be called for. This concerns the second research question investigated: "Do academic researchers" characteristics affect their perceptions on research integrity enablers?' This research aim was intended to explore whether there are academic characteristics that can inform targeted management initiatives to enhance research integrity.

The remainder of the paper is structured as follows. In the next section, we provide an overview of relevant literature in relation to the promotion of research integrity. We then discuss the research methods employed in the study in Section 3. In Section 4, we report how the data was collected and we present descriptive statistics of the sample. In Section 5, we present and discuss the study findings in relation to both research questions, followed by a concluding section.

2. Promoting research integrity

Previous research suggests that research misconduct is widespread in both developed and less developed countries (Ana et al. 2013; Fanelli 2009; Resnik and Master 2013). As has been re-confirmed recently (Berggren and Karabag 2019; Walsh, Lee, and Tang 2019), the incidence of such misconduct has also increased although incidence needs to be assessed in the overall context of improved detection and reporting of misconduct. While there are inter-country differences, inappropriate research behavior broadly comprises intentional malpractice (fabrication, falsification and plagiarism) and "questionable research practices" that may be problematic like the unauthorized use of confidential information, not fully disclosing research methods or findings, and inappropriate authorship attribution (Martinson, Anderson, and de Vries 2005; Steneck 2006). While Walsh, Lee, and Tang (2019) discuss the difficulties involved in defining and classifying the various degrees of research misconduct, Hall and Martin (2019) develop a useful taxonomy to distinguish different intermediate levels of questionable research behavior. They also provide an overview of the sources of irresponsible conduct of research drawn from a diverse set of theories including rational choice, bounded rationality, strain theory and cultural theories. In terms of underlying reasons for research misconduct, previous studies emphasize the "chasing citations" and "publish or perish" motivations that stem from academic career pressures in the context of quantitative research evaluations at individual and institutional levels (Anderson et al. 2007b; Bouter 2015; Honig et al. 2014; Martin 2013).

In light of the above, we investigated the perceived effectiveness of facilitating mechanisms in fostering research integrity and reducing the likelihood of research misconduct. Anderson et al. (2013) suggest five such

research integrity enablers: codes of conduct at the national and university levels, staff training, mentoring and peer pressure. We now discuss each of these briefly.

The Singapore Statement is an initiative aimed at transcending differences between countries by recognizing globally relevant aspects of research integrity. As noted above, recently published national codes of research conduct have, as intended (Resnik and Shamoo 2011), been modeled on the Singapore Statement. These codes attempt to foster responsible conduct regarding the way research, across academic disciplines, is carried out in the respective countries. Universities also develop their own codes of conduct that express expected standards in the context of the organization's "collective conscience" as it does in the case of disciplinary societies (Frankel 1989; American Association for the Advancement of Science 2000). There are several requirements for a code of conduct to have legitimacy and to provide genuine value to researchers. As Anderson et al. (2013) point out, this includes the involvement of interested parties in the development of the code, regular revisions of the code, and authentic implementation of the code. Giorgini et al. (2015) similarly observe that codes of conduct can be effective under certain circumstances including appropriate communication of the code of conduct and its acceptance by the members of the organization. To ensure legitimacy and create a culture of responsible research with an organization, research codes of conduct on their own are insufficient. Organizations also require systems to ensure the ability to report, investigate and punish wrongdoing and they need to provide organizational support for the code of conduct at all levels. It also requires embedding of the code into individual and organizational decision making.

Staff education and training can facilitate responsible research conduct. However, to be successful, research integrity education should be on-going and go beyond compliance to achieve genuine embracement of responsible research behavior. For instance, Bouter (2015) argues that mandatory training is not sufficient; rather, it requires a continuing learning process about "day-to-day dilemmas" (154). This reflects Antes et al.'s (2009) meta-analysis of evaluations of ethical behavior programmes. They find that effective programmes are, for instance, interactive and based on real-world case studies, and that training in which staff partake voluntarily is more effective than mandatory training. The above features are broadly consistent with Sefcik, Striepe, and Yorke (2019) study on academic integrity education programs. Steneck (2013) makes a case for harmonization of training in responsible research conduct based on common standards and common content albeit with some discipline or country-specific tailoring. He also advocates the use of the scientific method to study the "pedagogical disagreements" (553) about how research integrity training can promote appropriate research behavior.

Mentoring relationships can also play an important role in fostering responsible research conduct. For instance, Anderson et al. (2007a) find that ethics and research focused mentoring has a positive effect on responsible research conduct. Horbach and Halffman (2019) argue that mentoring is a suitable social control mechanism, like peer review for instance, that can keep research misconduct in check. They also suggest that measures to foster integrity often involve less experienced researchers. In that light, mentoring may be seen in the context of research supervision. However, that is not necessarily the case as shown in Bird (2001) who makes a distinction between the mentor role and the research supervisor role. She concludes that mentoring helps in "identifying and clarifying professional standards and ethical values" (p467). Fisher, Fried, and Feldman (2009, 498) distinguish between explicit mentoring ("direct instruction") and implicit mentoring ("observation of behaviors"). They find that, along with other factors such as departmental policies and faculty modeling behavior, mentoring plays a valuable role in relation to responsible research conduct.

Appropriate behavior modeling is relevant in the context of the effect of normative peer pressure in fostering research integrity. Not conforming to the accepted research integrity norms in the immediate work environment, or wider discipline, may risk condemnation by peers and possibly formal consequences, for instance by university management or a country's legal system. Anderson et al. (2013) usefully associate this with Merton's (1942) set of scientific norms and contend that peer pressure can be an effective social control mechanism. Naturally, the effect on responsible research conduct depends on the extent to which the norms are shared in the research community. In circumstances where those norms are not shared widely, adverse outcomes are possible. Walsh, Lee, and Tang (2019) invoke Merton's (1938) strain theory to show that this "can produce deviance, especially when there is strong external pressure for achievement and when legitimate means are difficult to pursue" (p448). The latter refers to the general academic research culture dominated by career-related pressures and competition referred to earlier. Perhaps only the strongest types of incentives can address research misconduct in such environments. This may involve the reporting of irresponsible research behavior by whistle blowers (Malek 2010).

3. Method

To address the main objective of this study, we used the Best-Worst Scaling (BWS) method in conjunction with latent class analysis. BWS is a method to elicit responses of relative importance among a list of items of interest. Latent class analysis identifies homogenous latent groups and the profiles of those groups in terms of group member characteristics. We now discuss the BWS method, the associated survey instrument and latent class analysis in turn.

3.1. *Best-Worst Scaling*

BWS is an established choice-based approach to assessing value or strength of preference of a list of items or objects (in this case, the researcher responsibilities) (Louviere et al. 2013; Louviere, Flynn, and Marley 2015). On the basis of an experimental design, those items are systematically allocated into different sub-sets (called "choice sets"), yielding a series of different combinations of items. In each choice set, respondents select the highest ranked and lowest ranked items (the "best" and "worst" items). Since this involves making trade-offs between items, the key distinguishing aspect, and advantage, of the BWS approach is that it enables a greater degree of discrimination compared with more common approaches such as item-by-item rating measurement. One weakness of the ratings method is the scope for response bias, i.e., response patterns not associated with the actual questions posed such as the tendency to agree or to use scale endpoints only (Baumgartner and Steenkamp 2001; Dolnicar and Gruen 2007). By analyzing how participants prioritize the items in the BWS choice sets, a pattern of relative importance can be established. It is worth emphasizing that, while the BWS approach allows for greater differentiation, BWS results may show that all items are of similar importance.

BWS also deals with the issue of scale use inequivalence which can occur with ambiguously or generically labeled rating scale points (Lee, Soutar, and Louviere 2007). For instance, a "strongly agree" rating option can be interpreted differently by different people, and ratings responses and people's views may not match which could result in errors in interpretation. In the case of BWS, responses are on a common choice-based scale which allows better comparison between respondents and, hence, better profiling of homogeneous groups.

Thurstone's (1927) random utility theory is the theoretical foundation for BWS. It essentially assumes that the relative importance of two items is a function of the relative choice frequencies of the two items subject to stochastic error (Louviere et al. 2013). McFadden's (1974) closed-form conditional logit model can be used to estimate the parameters that represent the utilities of the items of interest. This is conventionally done using maximum likelihood estimation of the BWS choice data as discussed in the latent class analysis below.

3.2. *The survey instrument*

The survey instrument used in the study consisted of three parts, the first of which contained the BWS choice sets. As alluded to above, there are 12 individual researcher responsibilities in the Singapore Statement. Anderson et al. (2013, 218) observe that the Singapore Statement "identifies integrity with the trustworthiness of research." Hence, the first item in the Singapore Statement ("Researchers should take responsibility for the trustworthiness of their

research") can be considered the overarching responsibility. This study focused on the remaining 11 researcher responsibilities that underly this overall responsibility. They are shown, including their full descriptions, in Table 1 as presented to participants at the start of Part A of the survey. It is worthwhile observing that the reason behind the order of the responsibilities in the Singapore Statement is not clear. The list is not alphabetical, nor does it appear to reflect the stages of the research process (as in the Netherlands Code of Conduct, for instance) since ethical considerations are the last responsibility on the list. Incidentally, ethical responsibility is phrased in terms of the societal costs and benefits of research. This is in line with Steneck (2006) who distinguishes research integrity ("research behavior viewed from the perspective of professional standards") from research ethics ("research behavior viewed from the perspective of moral principles").

To allocate the researcher responsibilities into BWS choice sets, a balanced incomplete block design was used. In accordance with this experimental design, each participant received the same series of 11 choices sets with each choice set containing different combinations of five researcher

Table 1. Researcher responsibilities, Singapore Statement.

Researcher responsibility	Description
Adherence to Regulations	Researchers should be aware of and adhere to regulations and policies related to research
Authorship	Researchers should take responsibility for their contributions to all publications, funding applications, reports and other representations of their research. Lists of authors should include all those and only those who meet applicable authorship criteria
Conflict of Interest	Researchers should disclose financial and other conflicts of interest that could compromise the trustworthiness of their work in research proposals, publications and public communications as well as in all review activities
Peer Review	Researchers should provide fair, prompt and rigorous evaluations and respect confidentiality when reviewing others' work
Public Communication	Researchers should limit professional comments to their recognized expertise when engaged in public discussions about the application and importance of research findings and clearly distinguish professional comments from opinions based on personal views
Publication Acknowledgment	Researchers should acknowledge in publications the names and roles of those who made significant contributions to the research, including writers, funders, sponsors, and others, but do not meet authorship criteria
Reporting Irresponsible Research Practices	Researchers should report to the appropriate authorities any suspected research misconduct, including fabrication, falsification or plagiarism, and other irresponsible research practices that undermine the trustworthiness of research, such as carelessness, improperly listing authors, failing to report conflicting data, or the use of misleading analytical methods
Research Findings	Researchers should share data and findings openly and promptly, as soon as they have had an opportunity to establish priority and ownership claims
Research Methods	Researchers should employ appropriate research methods, base conclusions on critical analysis of the evidence and report findings and interpretations fully and objectively
Research Records	Researchers should keep clear, accurate records of all research in ways that will allow verification and replication of their work by others
Societal Considerations	Researchers should recognize that they have an ethical obligation to weigh societal benefits against risks inherent in their work

responsibilities. Across the choice set design, each responsibility appeared five times and each pair of responsibilities appeared twice. Also, each responsibility appeared once in each of the five choice set positions, thereby dealing with any presentation position bias. Appendix A shows the first of the choice sets presented to respondents. While the shorter labels, taken from the Singapore Statement, were shown, respondents could see the full description of each responsibility in the online survey by hovering the cursor over the labels. Also, the survey was set up such that respondents could select only one "Most important" and one, different, "Least important" option.

Part B of the survey instrument, which is shown along with Part C in Appendix B, started with a question about awareness of the Singapore Statement followed by several questions regarding the five research integrity enablers discussed earlier. Respondents were asked to indicate their awareness of national and university research codes of conduct and of staff training, and to state their experiences of mentoring and of normative peer pressure in their immediate research environment to conduct research with integrity. In addition, we explored respondents' perceptions of the effectiveness of these enablers in promoting research integrity. Establishing whether or how the enablers affect actual research integrity behavior was beyond the scope of this study. Indeed, as the data below show, many respondents were not aware of some of the enablers considered. Given our intention to explore the general association between enabler effectiveness and academic characteristics, we, therefore, focused on perceived effectiveness. This was expressed on a scale that identifies different degrees of perceived contributions to fostering research integrity ("none", "some" and "major" as well as a "don't know" option).

Finally, in Part C, we gathered data on respondents' academic background: discipline, staff position, years of employment, research grant history, research publications history and country of employment. These background responses, along with the responses to the questions in Part B, were used as covariates to identify homogeneous groups in the latent class analysis which we discuss next.

3.3. *Latent class analysis*

As discussed above, a conditional logit model can be used to analyze BWS data. Using a maximum likelihood approach, this yields estimates of the utilities of the researcher responsibilities. In a latent class model, those utilities vary across discrete homogeneous classes (Kamakura and Russell 1989). The optimal number of classes, as well as the composition of those classes by way of covariates, is estimated simultaneously (Wedel and Kamakura 2000). The number of classes is determined by model information criteria values; these values incorporate model fit (the log-likelihood values) and model parsimony (the number of parameters). The model specification with the lowest information criterion value establishes the optimal number of classes.

Given membership of latent class c, the joint probability that responsibility r_1 is chosen by researcher i as the "*M*ost important" responsibility from all R responsibilities in choice set t, and that responsibility r_2 is chosen by that researcher as the "*L*east important" responsibility in that choice set can be expressed as:

$$\mathrm{P}(\mathrm{M_{it}} = \mathrm{r_1}|\mathrm{c}, \mathrm{R_t}) \cdot \mathrm{P}(\mathrm{L_{it}} = \mathrm{r_2}|\mathrm{M_{it}} = \mathrm{r_1}, \mathrm{c}, \mathrm{R_t}) \tag{1}$$

Equation 1 represents the sequential choice of the "Most important" responsibility in the choice set, followed by the conditional choice of the "Least important" responsibility from the remaining options. This translates into the following conditional logit expression where u represents the utility for each of the c classes:

$$\frac{\exp\left(\mathrm{u_{r_1|c,R_t}}\right)}{\int_1^{\mathrm{R}} \exp\left(\mathrm{u_{r|c,R_t}}\right)} \cdot \frac{\exp\left(-\mathrm{u_{r_2|c,R_t}}\right)}{\int_{1,\mathrm{r_1}\neq\mathrm{r_2}}^{\mathrm{R}} \exp\left(-\mathrm{u_{r|c,R_t}}\right)} \tag{2}$$

In our estimations, we also allowed for the estimation of heterogeneity in respondents' choice consistency (Dyachenko, Reczek, and Allenby 2014) as reflected in the (variance) scale values (Swait and Louviere 1993). We included two scale heterogeneity aspects: the overall identification of separate scale classes and the difference in variance between respondents' "Most important" and "Least important" choices.

4. Data

In this section, we first report how the study data were collected. We then present and summarize the characteristics of survey respondents in terms of their academic background and their views on research integrity enablers.

4.1. *Data collection*

The data were gathered between May and October 2018 through a survey administered by an Australian online survey company, with no payment incentives offered to participants. The target group of survey respondents were university staff members engaged in academic research either full-time or part-time. This comprised academic staff at various levels ranging from postdoctoral research staff to full professors. Since probability sampling was not feasible, we adopted a convenience sampling approach similar to Shaw and Satalkar (2018). To recruit survey participants, we used research management societies, as "umbrella organizations", in the promotion of the survey, in particular the International Network of Research Management Societies (INORMS), the Asia-Pacific Research Integrity Network (APRI),

the Australasian Research Management Society (ARMS) and the Australasian Ethics Network (AEN). At least one of the authors attended those bodies' conferences and made university research integrity managers, and people in similar research integrity related positions, aware of our study and asked for their support in promoting the survey among their respective universities' academic researchers. The research integrity managers nominated newsletters and e-mail as their main communication channels with academic staff. To help with that, we provided them with the wording for the survey participation invitation. This included the project's university ethics approval number and the following text to explain the nature and purpose of the study: "We use an online survey and a method called Best-Worst Scaling to assess academics' views on 'The Singapore Statement on Research Integrity' and we ask for broader perceptions of responsible research conduct. We hope to use the insights from this study to enhance efforts to promote integrity in academic research. The target audience is current academic staff members (including postdoctoral staff) at universities around the world who engage in academic research (whether full-time or part-time)."

Using the above recruitment approach, our aim was to achieve a broad sample across several dimensions of respondent characteristics including academic background as well as knowledge, interest and experience regarding research integrity. We acknowledge the limitations regarding the representativeness of the sample of the global community of university researchers and the associated broader inferences of the results. However, with a view to potential sample bias, we address the nature of the responses and the plausibility of the results explicitly below.

As per the protocol approved by the authors' university ethics committee, survey respondents were invited to access the online survey via a generic hyperlink, i.e., respondents could not be identified. Upon accessing the survey, respondents first saw a page containing a summary of the Participation Information Statement and Consent Form that addressed implied consent and withdrawal from the survey. They were told that completion of the survey was taken as implied consent and that they could withdraw from the survey at any time by closing the web browser or navigating away. It was also made clear that, if participants were to withdraw, their data would not be retained.

4.2. *Sample description*

The survey generated 321 fully completed responses. However, in their answer to Question C2 of the questionnaire, 19 respondents self-identified as non-academic staff members. These were mostly research students and university staff employed in research management roles. Hence, those responses were removed, resulting in a sample size of 302 academic research

staff. The median survey completion time was approximately 14 minutes. There is no guidance in the literature regarding a specific method to determine a minimum/required sample size for BWS (Cheung et al. 2016; Louviere et al. 2013). Cheung et al. (2016) analyze previous BWS studies in health care, a research field in which BWS is extensively used. Their findings show a weighted median sample size of 185 (and, for instance, a median sample size of 151 for the nine studies in 2015) for BWS applications like the one in the current study.

Table 2 displays the academic background of the survey respondents as per Part C of the questionnaire. The main disciplines in the sample are shown in the table. The proportions of STEM and non-STEM discipline groups were 64.9% and 35.1%, respectively. In terms of academic rank, the lower and higher echelons were more represented than the Senior/Principal Lecturer middle levels. Nearly 60% of the sample had been employed in the university sector for more than ten years while the majority of survey respondents had been recipients of a (recent) research grant or had had a refereed research publication in the last three years.

Nearly half of respondents were employed at an Australian university which, given the location of most recruitment intermediaries used for the survey, had been expected. In terms of the representation of continents, a few points are worth emphasizing: nearly all African respondents were from South Africa (Africa's total was 13.6% of the total sample); around three-quarters of Asian respondents (11.3%) were from China, with some responses from Singapore, Hong Kong and Thailand; Denmark represented

Table 2. Academic background, sample (n = 302).

Discipline	
Medical and Health Sciences	20.9%
Engineering and Technology	10.3%
Education	9.9%
Physical Sciences	8.9%
Biological Sciences	7.9%
Behavioral and Cognitive Sciences	6.6%
Economics	5.3%
Other	30.2%
Academic staff position	
Postdoctoral staff	18.9%
(Associate) Lecturer/Assistant Professor	20.5%
Senior/Principal Lecturer	18.2%
(Associate) Professor/Reader	42.4%
Years of employment	
< 5 years	19.9%
5–10 years	21.2%
11–15 years	17.5%
> 15 years	41.4%
Last competitive research grant	
Between 2015 and 2018	63.2%
Between 2010 and 2014	12.3%
Before 2010	6.0%
Never	18.5%
Last refereed research publication	
Between 2015 and 2018	91.4%
Between 2010 and 2014	4.0%
Before 2010	1.3%
Never	3.3%
Country of employment	
Australia	49.3%
South Africa	12.3%
Denmark	8.9%
United States	8.6%
China	8.3%
Other	12.6%

most of the European/UK representation (12.9%) which also included respondents from The Netherlands, Switzerland and the UK; and the USA was the sole American country in the sample. On the basis of the above sample diversity in terms of respondents' academic backgrounds, heterogeneity in the study findings is explored in the analysis below.

Table 3 contains the responses to the questions in Part B of the questionnaire, showing slightly abbreviated versions of the actual question and response labels. Interestingly, 66% of respondents overall indicated they were not familiar with the Singapore Statement. This two-thirds proportion of unawareness applied to Asia, Australia/New Zealand and Europe/UK while the number was higher for the US (85%) and lower for Africa (44%). Overall, the relatively low level of awareness of the Singapore Statement may suggest that the sampling approach did not generate a biased sample dominated by academic staff with a particular interest in, or knowledge of, research integrity matters. Of those who were aware of the Singapore Statement, most had learned about it through university newsletters and presentations or workshops.

The responses provide several noteworthy insights about the national and university-level research integrity enablers. Around 30% of respondents were not aware of a national research code of conduct in their country. Since not all countries have such a code, respondents from countries in which a national code does not exist expressed a relatively high level of unawareness (for instance, 69% for the US) while that level was much lower, for instance, for Denmark and Australia (19% and 21%, respectively) where such codes do exist. In relation to the latter two countries, 74% and 36% of respondents, respectively, felt that the national code of conduct is instilled among researchers. The above Danish results are not consistent with Davies (2019) who finds a very low degree of awareness and a high degree of indifference regarding the national code of conduct although that study involved Danish researchers from the natural sciences only. Some 28% of respondents in our study were not aware of research integrity training at their university, while just under 20% were not aware of a code of conduct at their university. While research integrity training and/or a code of conduct may not exist at all universities, these figures could not be broken down further since those data were not collected in the survey.

Just under a quarter of respondents had not had the experience of being in either a research mentee or research mentor role. Of those who had had experience in a mentoring relationship, most had done so in both formal and informal ways. Finally, around three-quarters of respondents indicated that there is normative peer pressure in their immediate research environment to conduct research with integrity.

The above results suggest that there appears to be scope to develop researcher awareness or experience in relation to both national and university-level integrity enablers. This is explored further in Section 5.2. Naturally,

Table 3. Research integrity perceptions, sample (n = 302).

Awareness of Singapore Statement (source)	
No	65.9%
Yes (university communication outlets)	9.3%
Yes (university presentation/workshop)	13.9%
Yes (colleague, own university)	3.6%
Yes (colleague, other domestic university)	2.3%
Yes (colleague, foreign university)	0.7%
Yes (other source)	4.3%
Awareness of national research code of conduct	
No	31.8%
Yes, but not publicized to researchers at my university	9.6%
Yes, publicized but not given sufficient prominence at my university	27.5%
Yes, and instilled among researchers at my university	31.1%
Effect of national research code of conduct on research integrity	
Does *not* contribute to fostering research integrity	5.6%
Makes *some* contribution to fostering research integrity	45.7%
Makes a *major* contribution to fostering research integrity	25.8%
I don't know	22.8%
Awareness of university research code of conduct	
No	18.5%
Yes, but not publicized to researchers at my university	8.3%
Yes, publicized but not given sufficient prominence at my university	35.1%
Yes, and instilled among researchers at my university	38.1%
Effect of university research code of conduct on research integrity	
Does *not* contribute to fostering research integrity	5.6%
Makes *some* contribution to fostering research integrity	48.3%
Makes a *major* contribution to fostering research integrity	32.5%
I don't know	13.6%
Awareness of research integrity staff training at university	
No	28.1%
Yes, and such staff training is mandatory	43.7%
Yes, and such staff training is not mandatory	28.1%
Effect of research integrity staff training on research integrity	
Does *not* contribute to fostering research integrity	6.3%
Makes *some* contribution to fostering research integrity	47.0%
Makes a *major* contribution to fostering research integrity	34.4%
I don't know	12.3%
Research mentee experience	
No	22.2%
Yes, formally and informally	40.1%
Yes, only formally	13.9%
Yes, only informally	23.8%
Research mentor experience	
No	24.5%
Yes, formally and informally	47.0%
Yes, only formally	6.6%
Yes, only informally	21.9%
Effect of research mentoring relationship on research integrity	
Does *not* contribute to fostering research integrity	1.3%
Makes *some* contribution to fostering research integrity	26.8%
Makes a *major* contribution to fostering research integrity	61.6%
I don't know	10.3%
Experience of normative peer pressure for research integrity	
No	26.8%
Yes, and *informal* counseling by peer in case of breach	43.4%
Yes, and *formal* referral by peers in case of breach	29.8%
Effect of normative peer pressure on research integrity	
Does *not* contribute to fostering research integrity	4.6%
Makes *some* contribution to fostering research integrity	39.7%
Makes a *major* contribution to fostering research integrity	46.4%
I don't know	9.3%

raising awareness of enablers is only relevant if such enablers are already in place. In cases where they are not, whether at national or university levels, this requires the development of enabling mechanisms in the first place.

Respondents indicated their perceived effectiveness of the various enablers with a view to fostering research integrity. Very few believed that these enablers do not contribute to research integrity at all; for that response category, the highest proportion was only 6.3% (for staff training). The greatest degree of uncertainty about the enabling effects applied to a national code of conduct (around 23%). Not surprisingly, the proportion was disproportionately high for the US (58%) where a national code does not exist.

Research mentoring and normative peer pressure were the two enablers for which "a major contribution" to research integrity exceeded the responses to the "some contribution" category. This was particularly evident for research mentoring where the proportions were 61.6% and 26.8%, respectively. In combination with the earlier results that approximately a quarter had not yet been in mentor-mentee relationships or had not felt peer pressure to conduct research with integrity, there appears to be potential to enhance the use of those two research integrity enablers. This will be discussed later in terms of university research management guidance.

At the end of the questionnaire, respondents were invited to comment on the Singapore Statement, on academic research integrity more generally or on the survey. A total of 82 comments were received from 72 people. Nearly half of the comments made were about research integrity broadly while 20 comments were made about the Singapore Statement or the survey. It is beyond the scope of this paper to discuss those comments in detail but some of them will be used below for illustration purposes.

5. Results and discussion

In this section, we discuss the results in relation to both research questions.

5.1. *Hierarchy of researcher responsibilities*

Latent Gold Choice (version 5.0, Statistical Innovations) was used to estimate the latent class models. Before turning our attention to the identification of latent classes, we first present the aggregate sample results of the overall model in which homogeneity in the sample is assumed – see Table 4. The pseudo-R^2 values reported are interpreted differently to R^2 values in conventional regression models. The values here refer to the reduction in prediction errors (for "Most important" and "Least important" choices) compared with a baseline model that assumes equal probabilities for all options in the choice set. We will compare the pseudo-R^2 values for this aggregate model with those for the latent class model shortly.

Table 4. Estimation results, sample aggregate (n = 302).

Researcher responsibility	Parameter	Probability
Research Methods	1.373	28.4%
Research Records	0.375	10.5%
Reporting Irresponsible Research Practices	0.346	10.2%
Conflict of Interest	0.310	9.8%
Adherence to Regulations	0.297	9.7%
Research Findings	0.260	9.3%
Peer Review	−0.026	7.0%
Authorship	−0.276	5.5%
Societal Considerations	−0.335	5.2%
Publication Acknowledgment	−1.160	2.3%
Public Communication	−1.161	2.3%
		100%
Pseudo R^2 "Most" = 0.242		
Pseudo R2 "Least" = 0.275		

The second column of Table 4 shows the estimated parameters for each of the 11 researcher responsibilities in the Singapore Statement. The parameters denote utility values that represent the relative importance of each responsibility in the hierarchy, shown in descending order in the table. Using the logit transformation, each parameter can be expressed as the probability of that responsibility being selected as most important across all 11 responsibilities. Those probabilities, shown in the third column of the table, therefore, reflect the importance of the items relative to each other. The results indicate that "research methods" is the most important responsibility (with a choice probability of approximately 28%). It is followed by a group of five responsibilities with a choice probability of around 10%. The pattern of relative importance reveals that "public communication" and "publication acknowledgement" are perceived to be the least important researcher responsibilities of the Singapore Statement. It should be noted that, while those two responsibilities have the lowest relative importance, the results do not imply that they are not important in an absolute sense.

With a view to assessing potential country bias in the sample, in particular the high proportion of Australian responses, we compared the results for Australia and the other countries. The correlation between the two sets of estimated parameters was high (correlation coefficient = 0.95) which indicates that the above overall pattern of relative importance was very similar for Australian and non-Australian researchers in the sample.

In the next step of the analysis, we investigated heterogeneity within the sample, i.e., we tested whether homogenous latent groups ("classes") of academic researchers can be established. As discussed above, this involves estimating a series of model specifications that differ in terms of the number of scale classes and latent preference classes and finding minimum information criterion values to determine the best specification. The values for the BIC and CAIC information criteria were lowest for a model specified with four preference classes and two scale classes.

The estimation results for that model are displayed in Table 5. The sizes of the latent classes range from 42% (Class 1) to 15% (Class 4). The pseudo-R^2 values show that this model has greater predictive power than the aggregate model of Table 4, in particular regarding the "Most important" choices. With a view to strength of classification, the entropy-R^2 value, which is an indicator for the assignment of respondents to the homogeneous latent classes, is close to the upper boundary value of one which signifies the robustness of the latent class model. Further, the Wald statistic shows that the estimated parameters are not equal between classes.

While the estimated coefficients of the researcher responsibilities are the focus in the current context, it is worthwhile considering briefly the estimated scale values toward the bottom of the table. These values, which measure the consistency of respondents' choices in the BWS questions, were both statistically significant. Scale class 2 (which contains around half of the sample) had a smaller response variance than the first (reference) class by around 40% (e-0.862). Further, the estimation results show that the choice consistency of respondents' "Least important" choices was around 70% (e-0.361) of the "Most important" responses; i.e., respondents were somewhat less certain in their selection of the "Least important" items in the BWS task. This was reflected in some of the survey comments; of the ten comments expressing that the survey was "difficult" or "tedious", two respondents explicitly stated that selecting the "Least important" responsibility in a choice set was particularly difficult. On the other hand, two other respondents also commented that they liked being forced to choose between responsibilities.

Table 5. Estimation results, latent classes.

Researcher Responsibility	Class 1 (42%)	Class 2 (24%)	Class 3 (20%)	Class 4 (15%)
Adherence to Regulations	−0.643	3.705	−0.644	1.976
Authorship	0.022	−2.920	−0.462	0.676
Conflict of Interest	0.090	0.754	1.353	1.724
Peer Review	0.689	−0.027	−0.634	0.196
Public Communication	−2.634	−3.937	−1.631	−3.956
Publication Acknowledgment	−2.190	−5.141	−2.741	−0.535
Reporting Irresponsible Research Practices	−0.613	2.430	1.180	2.543
Research Findings	2.461	0.679	−0.673	−2.699
Research Methods	3.701	2.389	2.062	2.209
Research Records	1.345	1.398	−0.469	1.466
Societal Considerations	−2.229	0.669	2.658	−3.601
Scale value, Scale Class 2[a]: −0.862 Scale value, 'Least'[a]: −0.361				
Pseudo R^2 "Most" = 0.427 *Pseudo R2 "Least" = 0.350* *Entropy R^2 = 0.932* *Wald = 493.878, p <.001*				

[a]Reference case.

The scale values represent one issue of heterogeneity, i.e., choice consistency. However, of most interest in the current study is heterogeneity across respondents in terms of the relative importance of the researcher responsibilities. The latter is reflected in the estimated utilities for each of the four latent preference classes in Table 5. The estimation also included covariates to profile those classes. These covariates comprised the responses to the questions in Parts B and C of the survey. For three covariates, responses were re-categorized into a smaller number: a binary variable for awareness of the Singapore Statement, a binary variable for academic discipline (STEM vs. Non-STEM) and five categories for country of employment representing five broad continents. The model produced the classification of each respondent into one of the four classes based on the largest class membership probability.[1] The estimation showed that several covariates were statistically significant across the classes. Chi-square tests were used to establish significant differences between classes for each covariate, applying the conservative approach of a Bonferroni correction – the results are shown in Table 6. We now discuss these results in conjunction with the choice probabilities for each of the classes (converted from the estimated utilities in Table 5), shown as bars in Figure 1. As reference points in that figure, the black circles are the aggregate sample probabilities (as per the last column in Table 4).

Class 1 is the largest of the four classes (42% of the sample). It differs from the other classes in terms of researchers' STEM background and their view that a national research code of conduct has some effect on research integrity. The key feature of this class is that 'research methods' is the most important researcher responsibility. The probability of 48% is greater than that for the sample overall and it exceeds those of the other responsibilities. The next highest probability is that of "research findings" which, at 19%, is also higher than for the other three classes. Referring to the full description of "research methods" in the Singapore Statement, researchers in this class feel that, first and foremost, they should use suitable methods, obtain evidence-based conclusions based on critical analysis and report results fully and in an objective manner. The association between the dominance of the research methods responsibility and the STEM background in this class appears plausible given the long-standing notion of the scientific method.

Class 2, with a size of 24%, also has one outstanding responsibility, viz. "adherence to regulations", i.e., academic researchers should be familiar with and follow research-related regulations and policies. The 40% probability for this responsibility is more than twice as high as that of the next two ("reporting irresponsible research practices" and "research methods"). "Adherence to regulations" is of major importance only to those in Class 2. Three research integrity enablers are the differentiating factors for this class: a major effect of a national research code of conduct, awareness of mandatory integrity staff training at their university and a major effect of normative peer pressure.

Table 6. Class descriptors.

	Class 1	Class 2	Class 3	Class 4
Perceived effect of national research code of conduct on research integrity (χ^2 = 0.001)				
A National Code does not contribute to fostering research integrity.	4.7%	2.8%	5.1%	13.6%
A National Code makes some contribution to fostering research integrity.	**55.5%**	46.5%	37.3%	*27.3%*
A National Code makes a major contribution to fostering research integrity.	*17.2%*	**38.0%**	32.2%	22.7%
I don't know if a National Code contributes to fostering research integrity.	22.7%	*12.7%*	25.4%	**36.4%**
Awareness of research integrity staff training at university (χ^2 = 0.003)				
No.	32.8%	16.9%	27.1%	34.1%
Yes, and such staff training is mandatory.	39.1%	**62.0%**	*30.5%*	45.5%
Yes, and such staff training is not mandatory.	28.1%	21.1%	42.4%	20.5%
Perceived effect of normative peer pressure on research integrity (χ^2 = 0.004)				
Normative peer pressure does not contribute to fostering research integrity.	3.9%	4.2%	*0.0%*	**13.6%**
Normative peer pressure makes some contribution to fostering research integrity.	46.1%	32.4%	40.7%	31.8%
Normative peer pressure makes a major contribution to fostering research integrity.	*38.3%*	**60.6%**	50.8%	40.9%
I don't know if normative peer pressure contributes to fostering research integrity.	11.7%	2.8%	8.5%	13.6%
Discipline (χ^2 < 0.001)				
STEM	**78.1%**	59.2%	*42.4%*	65.9%
Non-STEM	*21.9%*	40.8%	**57.6%**	34.1%
Continent/country of employment (χ^2 = 0.017)				
Africa	13.3%	22.5%	10.2%	4.5%
Asia	13.3%	8.5%	10.2%	11.4%
Australia/New Zealand	50.0%	54.9%	57.6%	56.8%
Europe/UK	15.6%	*2.8%*	**20.3%**	11.4%
United States	7.8%	11.3%	*1.7%*	**15.9%**

Column percentages add to up one for each covariate.
Bonferroni correction $\alpha < 0.05$. Where significant differences exist, the **largest** class proportion is bolded and the *smallest* class proportion is italicized.

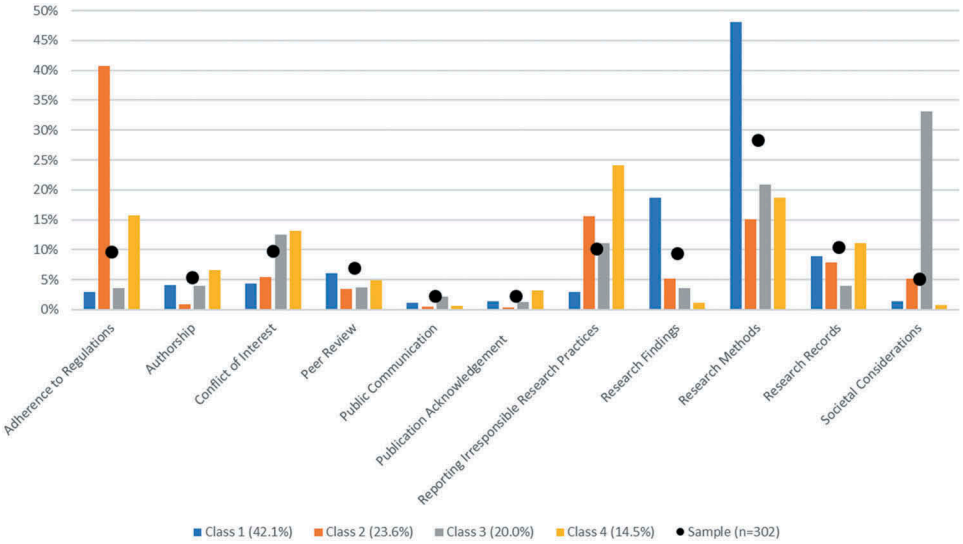

Figure 1. Probability of being selected as "most important" researcher responsibility.

To those belonging to Class 3, almost equal in size to the second class, "societal considerations" is the most important researcher responsibility. This pertains to the ethical assessment of a research project's societal benefits and risks. Behind "research methods", this class attaches approximately equal importance to "conflict of interest" and "reporting irresponsible research practices". Academic researchers in this class differ from the other classes in relation to their non-STEM background and their employment at a European/UK university. The latter may reflect the individualism-collectivism dimension of Hofstede, Hofstede, and Minkov (2010) cultural dimensions theory since nearly all European/UK researchers in the sample were employed in Denmark, The Netherlands and Switzerland. These three countries have low individualism scores of 74, 80 and 68, respectively (Hofstede Insights), compared, for instance, with Australia, the UK and the US (90, 89 and 91, respectively), suggesting a higher degree of societal perspective.

The last class, the smallest of the four, has the most balanced pattern of probabilities. It generally resembles the sample overall, except for the responsibility of reporting research misconduct and other irresponsible practices which is the most important one for this class only. This class is differentiated from the other classes in relation to their belief that peer pressure is not an enabler of research integrity, their uncertainty about the effect of a national code of conduct and their employment at a US university. The latter two appear consistent with the earlier observation that there is no national research code in the US. The US background of this class may accord with the monetary incentives in the US for whistle blowers to report research misconduct such as in the recent case involving falsified research at Duke University (Dinan 2019).

Overall, the above results suggest the value of pursuing an analysis of heterogeneity. We have established four homogeneous classes, three of which have one different researcher responsibility that stands out from the rest while the fourth class displays a more balanced pattern. This provides a richer picture than the sample-wide results that suggest the dominance of "research methods" only. Further, the plausibility of the above findings may alleviate some concerns in relation to potential sample bias due to the convenience sampling approach adopted.

5.2. *Diversity in perceptions on research integrity enablers*

The above latent classes suggest that the relative importance of researcher responsibilities is perceived differently by different researchers in various terms including academic background. From a research integrity management perspective, the pattern of results established may not reflect the conditions conducive to responsible research conduct. For instance, researchers may overlook the importance of certain researcher responsibilities such as disclosing conflicts of interest or rigorous peer review as a gatekeeping mechanism. To the extent that this is the case, enablers can be used as research integrity management interventions in an attempt to alter researchers' views.

The latent class results provide initial policy guidance in that respect. Academic staff who believe that adherence to regulations is the main researcher responsibility (Class 2) perceive normative peer pressure and, to a lesser extent, a national code of conduct as effective research integrity enablers. Also, the sample descriptives of the integrity enablers of Table 3 suggest that research mentoring relationships and normative peer pressure are, broadly, two integrity enablers worth pursuing.

To address the second research question in detail, we explored inter-group differences in relation to researchers' perceptions on enablers by way of Chi-square analysis using Bonferroni corrections. The results provide insights into the prospects of targeted interventions, i.e., they suggest potentially suitable enablers for different types of academic characteristics. All original awareness and perception response categories were used except for academic discipline (using a binary STEM vs. Non-STEM variable) and country of employment (using five categories representing five broad continents). While we analyzed all enabler responses, we only report the cases with significant differences between academic backgrounds in Table 7.[2] We now discuss the results for each of the five enablers.

With respect to a national research code of conduct, the only point of difference was in relation to country of employment. While those employed at universities in Australia/New Zealand were most aware of a national code (78%), 36% thought it was not given enough prominence. This was unlike researchers in Europe/UK, 62% of whom felt that the national code was inculcated among

Table 7. Research integrity enablers – differences by academic background.

Enabler	Academic Discipline	Academic position	Years of employment	Research grant	Research publication	Country group
National Code – Awareness						✓***
National Code – Perceived effectiveness						✓**
University Code – Awareness		✓*				✓*
University Code – Perceived effectiveness		✓*	✓*			
Staff Training – Awareness		✓**		✓*		✓***
Staff Training – Perceived effectiveness			✓**			
Research Mentee – Experience		✓**	✓**			✓**
Research Mentor – Experience		✓***	✓***	✓***		
Research Mentoring Relationship – Perceived effectiveness						
Peer Pressure – Experience						
Peer Pressure – Effectiveness			✓*		✓**	

***Pearson Chi-Square, $p < 0.001$,**Pearson Chi-Square, $0.001 < p < 0.01$, *Pearson Chi-Square, $0.01 < p < 0.05$.

researchers at their university. This suggests the need for universities (and national research bodies) in Australia/New Zealand to better convince their researchers of the value of a national code. Following Steneck (2013), this raises the issue of the most suitable pedagogy to achieve this. Researchers in the US were least aware of the existence of a national code (69%). As observed earlier, in that light, it is not surprising that US researchers were also less certain about the perceived effectiveness of a national code (58%) than those from other countries.

The awareness of a university research code of conduct differed in terms of academic position and country of employment. Nearly 18% of those employed at the (Associate) Lecturer/Assistant Professor level indicated that they were aware of such a university code but that this was not publicized to researchers at their university. This implies a need to better inform academic staff at those lower employment levels of a university code. With a view to country background, researchers from Australia/New Zealand were most aware while those from Asia were least aware. The latter suggests the need to enhance the awareness of a university code of conduct where such a code exists. In terms of the perceived effectiveness of a university code, those employed in the middle ranks (Senior/Principal Lecturer) and around their mid-career (11–15 years of employment) were least convinced that such a code contributes to fostering research integrity (15% and 11%, respectively). Interestingly, of those with less than five years of academic employment, nobody thought that a university code makes no contribution at all. The above diversity of responses is consistent with Giorgini et al. (2015) who observe mixed findings in studies regarding university research codes of conduct.

Around 45% of respondents at the (Associate) Lecturer/Assistant Professor level were not aware of staff training regarding research integrity at their

university. The highest proportion of unawareness was for those who had not had a research grant for more than eight years (56%). This may be due to university policies that stipulate mandatory research integrity training for researchers who have secured grants. In terms of country of employment, the lack of awareness applied most to researchers from Asia (50%) while mandatory staff training was perceived to be least prevalent in Africa (10%). Mid-career researchers were least confident about the effectiveness of staff training. Nearly two-thirds had the perception that such training only made some contribution to fostering research integrity.

Inter-group differences regarding mentoring experience revealed an expected pattern. Those employed at lower academic ranks and with a shorter academic employment duration were more likely to have been a mentee and least likely to have been a mentor. The inverse was the case for the highest academic employment levels and for longer tenure. One exception was in relation to experience with an informal mentoring role. Researchers in a postdoc position were most likely to have had such experience (35%). This suggests a work environment that facilitates providing informal support to more junior postdocs. Further, all respondents from the US indicated that they had had some mentee experience. Also, researchers who had not received a research grant were more likely to be without any mentoring experience. In terms of the perceived effectiveness of research mentoring, there were no differences between academic background groups. In other words, the perceived major contribution of mentoring to research integrity, established earlier, was shared across academic backgrounds in the sample.

There were also no significant differences between researcher groups regarding peer pressure experience in their research environment. As shown earlier in relation to the sample overall, around three-quarters reported experiencing such pressure to carry out research with integrity. Of those, 60% indicated that those breaching integrity norms would be counseled by their peers informally. In relation to the perceived effectiveness of normative peer pressure in promoting responsible research conduct, there were two differences across academic backgrounds. Researchers without a refereed research publication were most unsure about that effect of peer pressure (40%). Further, those with the longest tenure in academia, were least likely to see no beneficial contribution of peer pressure on research integrity (1.6%) as opposed to those employed between 5 to 10 years (10.9%). Haven et al. (2019), in a study of researchers at Amsterdam universities, find that researchers employed at higher academic positions and those in the natural sciences perceived a relatively more positive research integrity climate, for instance regarding integrity norms. Those results were not corroborated in the current study as we did not find significant differences in terms of academic rank or discipline.

Overall, the above results indicate that there are several differences between the perceived effects of research integrity enablers, particularly in terms of academic position, the duration of academic employment and country of employment. This suggests that staff with those different academic backgrounds may be receptive to research integrity enablers to different extents. Hence, research integrity intervention initiatives may be usefully informed by those characteristics. Interestingly, the analysis showed no differences in terms of STEM vs. non-STEM disciplines, suggesting a consensus across discipline groups about the perceived effect of the various research integrity enablers.

6. Conclusion

In this study, we have established two main findings in relation to the two research questions. Regarding the first research question, using the individual researcher responsibilities from the Singapore Statement, we identified different hierarchies of responsibilities for four groups of academic researchers, and we profiled those groups in terms of academic backgrounds. For three of the four groups, one researcher responsibility dominated the others, and that responsibility was a different one for each group.

In relation to the second research question, the results showed different degrees of perceived effectiveness of research integrity enablers depending on the nature of academic background including academic position, academic tenure and country of employment. Hence, based on academic perceptions, a one-size-fits-all approach to research integrity support is not expected to be successful.

With a view to future research, we propose several avenues. While our study has focused on the relative importance of researcher responsibilities, it does not address the reasons behind the findings. As one respondent pointed out in the open-ended comments in the survey: "different elements overlap and take priority in different circumstances". It would be interesting to investigate this in a follow-up study. In particular, a qualitative study might help interpret the results and provide further insights. For instance, does the domination of the "research methods" responsibility as perceived by STEM researchers apply overall or do other responsibilities become more important in different stages of the research process? For instance, when focusing on the final stages of that process, would the importance of peer review as a "gatekeeper" come to the fore?

Further, our findings suggest differences in the perceived effectiveness of research integrity enablers in terms of academic backgrounds. However, there may well be other relevant researcher characteristics, such as personal traits, worthwhile investigating in future research. Such research may also shed light on the underlying reasons behind the differences in perceptions of enabler effectiveness as well as the association between

perceived effectiveness and actual behavior. This, in turn, would then inform the crucial issue of suitable pedagogies required for successful targeted interventions.

Our findings reveal some continent/country-related differences in the class profiles such as the relatively high importance of "societal considerations" and "reporting of irresponsible practices" in Europe and the US, respectively. It would be interesting for future research to explore this further, for instance by considering the differences between individualist and collectivist societies. In particular, is there a broad association between the emphasis on legislative, compliance-based research conduct and individual responsibility in a country like the US, as opposed to conduct based on norms reflected in principles-based codes in countries classified as more collectivist?

In addition to the limitations implied in the above suggestions for future research, there are others that suggest further work. The findings of the current research are based on data collected from a convenience sample. It does not appear that most of the respondents had a particular interest in, or knowledge about, research integrity, and the latent class findings appear to be plausible. However, we are not suggesting that this provides evidence that the sample represents the global population of academic researchers. Indeed, we acknowledge the limitations of the small sample size regarding the representativeness of the sample and the associated broader inferences of the results. Where possible, therefore, it would be worthwhile for future research to generate data using a probability-based sampling approach.

Relatedly, while the data allowed the generation of robust latent class results in terms of homogeneous classes, it would be good to have a broader sample, for instance with a wider variety of countries outside Australia. Further, our focus on the Singapore Statement could be extended to other researcher responsibility frameworks such as national codes of conduct.

Despite its limitations, our study helps advance our understanding of integrity in academic research, in particular researchers' perceptions of their research integrity responsibilities and their perceptions of associated integrity enablers. As such, the study findings are relevant to higher education researchers as well as research integrity practitioners.

Notes

1. The model estimates for the covariates and the modal classifications are available upon request from the corresponding author.
2. The full results are available upon request from the corresponding author.

Acknowledgments

We are grateful to the representatives of the research management societies and university research integrity units who facilitated the distribution of the survey through their networks.

Human research ethics approval was obtained through UNSW (HREAP No HC171045). One of the authors (D. H. Rohr) declared his Conflict of Interest as the Director of Research Ethics & Compliance Support at UNSW prior to submission of the application and during the approval process and monitoring.

Funding

This work was supported by The University of New South Wales (UNSW).

References

American Association for the Advancement of Science – AAAS. 2000. *The Role and Activities of Scientific Societies in Promoting Research Integrity: A Report of a Conference*, April 10–11. Accessed 29 March 2019. https://www.aaas.org/sites/default/files/content_files/The Role and Activities of Scientific Societies in Promoting Research Integrity.pdf

Ana, J., T. Koehlmoos, R. Smith, and L. Yan. 2013. "Research Misconduct in Low- and Middle-Income Countries." *PLoS Medicine* 10 (3): e1001315. doi:10.1371/journal.pmed.1001315.

Anderson, M., M. Shaw, N. Steneck, E. Konkle, and T. Kamata. 2013. "Research Integrity and Misconduct in the Academic Profession." In *Higher Education: Handbook of Theory and Research*, edited by M. Paulsen, 217–261. Vol. 28. Dordrecht: Springer.

Anderson, M. S., A. S. Horn, K. R. Risbey, E. A. Ronning, R. De Vries, and B. C. Martinson. 2007a. "What Do Mentoring and Training in the Responsible Conduct of Research Have to Do with Scientists' Misbehavior? Findings from a National Survey of NIH-Funded Scientists." *Academic Medicine* 82 (9): 853–860. doi:10.1097/ACM.0b013e31812f764c.

Anderson, M. S., E. A. Ronning, R. De Vries, and B. C. Martinson. 2007b. "The Perverse Effects of Competition on Scientists' Work and Relationships." *Science and Engineering Ethics* 13 (4): 437–461. doi:10.1007/s11948-007-9042-5.

Antes, A., S. Murphy, E. Waples, M. Mumford, R. Brown, S. Connelly, and L. Devenport. 2009. "A Meta-analysis of Ethics Instruction Effectiveness in the Sciences." *Ethics and Behavior* 19 (5): 379–402. doi:10.1080/10508420903035380.

Australian Code for the Responsible Conduct of Research. 2018. "National Health and Medical Research Council." Accessed 14 May 2019. https://www.nhmrc.gov.au/sites/default/files/documents/attachments/the-australian-code-for-the-responsible-conduct-of-research-2018.pdf

Baumgartner, H., and J. Steenkamp. 2001. "Response Styles in Marketing Research: A Cross-national Investigation." *Journal of Marketing Research* 38 (2): 143–156. doi:10.1509/jmkr.38.2.143.18840.

Berggren, C., and S. F. Karabag. 2019. "Scientific Misconduct at an Elite Medical Institute: The Role of Competing Institutional Logics and Fragmented Control." *Research Policy* 48: 428–443. doi:10.1016/j.respol.2018.03.020.

Bird, S. 2001. "Mentors, Advisors and Supervisors: Their Role in Teaching Responsible Research Conduct." *Science and Engineering Ethics* 7 (4): 455–468. doi:10.1007/s11948-001-0002-1.

Bouter, L. M. 2015. "Commentary: Perverse Incentives or Rotten Apples?" *Accountability in Research: Policies and Quality Assurance* 22 (3): 148–161. doi:10.1080/08989621.2014.950253.

Cheung, K., B. Wijnen, I. Hollin, E. Janssen, J. Bridges, S. Evers, and M. Hiligsmann. 2016. "Using Best–Worst Scaling to Investigate Preferences in Health Care." *PharmacoEconomics* 34: 1195–1209. doi:10.1007/s40273-016-0429-5.

Couch, S., and S. Dodd. 2005. "Doing the Right Thing: Ethical Issues in Higher Education." *Journal of Family and Consumer Sciences* 97 (3): 20–26.

Davies, S. 2019. "An Ethics Of The System: Talking to Scientists about Research Integrity." *Science and Engineering Ethics* 25 (4): 1235-1253. doi:.

Dinan, S. 2019. "Duke University to Pay $112.5 Million Settlement for Faked Research." *Washington Times*, March 25. Accessed 14 May 2019. https://www.washingtontimes.com/news/2019/mar/25/duke-pay-1125m-settlement-faked-research

Dolnicar, S., and B. Gruen. 2007. "Cross-cultural Differences in Survey Response and Patterns." *International Marketing Review* 24 (2): 127–143. doi:10.1108/02651330710741785.

Dyachenko, T., R. W. Reczek, and G. M. Allenby. 2014. "Models of Sequential Evaluation in Best-worst Choice Tasks." *Marketing Science* 33 (6): 828–848. doi:10.1287/mksc.2014.0870.

Fanelli, D. 2009. "How Many Scientists Fabricate and Falsify Research? A Systematic Review and Meta-analysis of Survey Data." *PLoS One* 4: e5738. doi:10.1371/journal.pone.0005738.

Fanelli, D., J. P. A. Ioannidis, and S. Goodman. 2018. "Improving the Integrity of Published Science: An Expanded Taxonomy of Retractions and Corrections." *European Journal of Clinical Investigation* 48: e12898. doi:10.1111/eci.12898.

Fisher, C., A. Fried, and L. Feldman. 2009. "Graduate Socialization in the Responsible Conduct of Research: A National Survey on the Research Ethics Training Experiences of Psychology Doctoral Students." *Ethics and Behavior* 19 (6): 496–518. doi:10.1080/10508420903275283.

Frankel, M. 1989. "Professional Codes: Why, How, and with What Impact." *Journal of Business Ethics* 8 (2): 109–115. doi:10.1007/BF00382575.

Giorgini, V., J. T. Mecca, C. Gibson, K. Medeiros, M. D. Mumford, S. Connelly, and L. D. Devenport. 2015. "Researcher Perceptions of Ethical Guidelines and Codes of Conduct." *Accountability in Research: Policies and Quality Assurance* 22 (3): 123–138. doi:10.1080/08989621.2014.955607.

Hall, J., and B. R. Martin. 2019. "Towards a Taxonomy of Research Misconduct: The Case of Business School Research." *Research Policy* 48: 414–427. doi:10.1016/j.respol.2018.03.006.

Haven, T. L., J. K. Tijdink, B. C. Martinson, and L. M. Bouter. 2019. "Perceptions of Research Integrity Climate Differ between Academic Ranks and Disciplinary Fields: Results from a Survey among Academic Researchers in Amsterdam." *PLoS ONE* 14 (1): e0210599. doi:10.1371/journal.pone.0210599.

Hofstede, G., G. J. Hofstede, and M. Minkov. 2010. *Cultures and Organizations: Software of the Mind*. Rev. 3rd ed. New York: McGraw-Hill.

Hofstede Insights. Accessed 2 May 2019. https://www.hofstede-insights.com/product/compare-countries

Honig, B., J. Lampel, D. Siegel, and P. Drnevich. 2014. "Ethics in the Production and Dissemination of Management Research: Institutional Failure or Individual Fallibility?" *Journal of Management Studies* 51 (1): 118–142. doi:10.1111/joms.2014.51.issue-1.

Horbach, S. P. J. M., and W. Halffman. 2019. "The Extent and Causes of Academic Text Recycling or 'Self-plagiarism'." *Research Policy* 48: 492–502. doi:10.1016/j.respol.2017.09.004.

Hosseini, M., M. Hilhorst, I. De Beaufort, and D. Fanelli. 2018. "Doing the Right Thing: A Qualitative Investigation of Retractions Due to Unintentional Error." *Science and Engineering Ethics* 24: 189–206. doi:10.1007/s11948-017-9894-2.

Kamakura, W. A., and G. J. Russell. 1989. "A Probabilistic Choice Model for Market Segmentation and Elasticity Structuring." *Journal of Marketing Research* 26: 379–390. doi:10.1177/002224378902600401.

Kaminskii, A. 2012. "The Singapore Statement on Research Integrity." *Physics Status Solidi A* 209 (1): 3–4. doi:10.1002/pssa.201221902.

Lee, J. A., G. Soutar, and J. J. Louviere. 2007. "Measuring Values Using Best–worst Scaling: The LOV Example." *Psychology and Marketing* 24 (12): 1043–1058. doi:10.1002/()1520-6793.

Louviere, J., I. Lings, T. Islam, S. Gudergan, and T. Flynn. 2013. "An Introduction to the Application of (Case 1) Best–worst Scaling in Marketing Research." *International Journal of Research in Marketing* 30: 292–303. doi:10.1016/j.ijresmar.2012.10.002.

Louviere, J., T. Flynn, and A. Marley. 2015. *Best–Worst Scaling; Theory, Methods and Applications*. Cambridge: Cambridge University Press.

Malek, J. 2010. "To Tell or Not to Tell? The Ethical Dilemma of the Would-Be Whistleblower." *Accountability in Research: Policies and Quality Assurance* 17 (3): 115–129. doi:10.1080/08989621003791929.

Martin, B. R. 2013. "Whither Research Integrity? Plagiarism, Self-plagiarism and Coercive Citation in an Age of Research Assessment." *Research Policy* 42 (5): 1005–1014. doi:10.1016/j.respol.2013.03.011.

Martinson, B., M. Anderson, and R. de Vries. 2005. "Scientists Behaving Badly." *Nature* 435: 737–738. doi:10.1038/435737a.

McFadden, D. 1974. "Conditional Logit Analysis of Qualitative Choice Behavior." In *Frontiers in Econometrics*, edited by P. Zarembka, 105–142. New York: Academic Press.

Merton, R. K. 1938. "Social Structure and Anomie." *American Sociological Review* 3: 672–682. doi:10.2307/2084686.

Merton, R. K. 1942. "A Note on Science and Democracy." *Journal of Legal and Political Sociology* 1 (1–2): 115–126.

Netherlands Code of Conduct for Research Integrity. 2018. "KNAW, NFU, NWO; TO2-Federatie; NAUAS, VS, VSNU." Accessed 14 September 2019. https://www.vsnu.nl/files/documents/Netherlands Code of Conduct for Research Integrity 2018.pdf

Resnik, D., and A. Shamoo. 2011. "The Singapore Statement on Research Integrity." *Accountability in Research: Policies and Quality Assurance* 18 (2): 71–75. doi:10.1080/08989621.2011.557296.

Resnik, D., and Z. Master. 2013. "Policies and Initiatives Aimed at Addressing Research Misconduct in High-Income Countries." *PLoS Medicine* 10 (3): e1001406. doi:10.1371/journal.pmed.1001406.

Sefcik, L., M. Striepe, and J. Yorke. 2019. "Mapping the Landscape of Academic Integrity Education Programs: What Approaches are Effective?" *Assessment and Evaluation in Higher Education*. Advance online publication. doi:10.1080/02602938.2019.1604942.

Shaw, D., and P. Satalkar. 2018. "Researchers' Interpretations of Research Integrity: A Qualitative Study." *Accountability in Research: Policies and Quality Assurance* 25 (2): 79–93. doi:10.1080/08989621.2017.1413940.

Singapore Statement on Research Integrity. 2010. Accessed 14 May 2019. https://wcrif.org/guidance/singapore-statement

Steneck, N. 2006. "Fostering Integrity in Research: Definitions, Current Knowledge, and Future Directions." *Science and Engineering Ethics* 12: 53–74. doi:10.1007/s11948-006-0006-y.

Steneck, N. 2013. "Global Research Integrity Training." *Science* 340: 552–553. doi:10.1126/science.1236373.
Swait, J., and J. J. Louviere. 1993. "The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models." *Journal of Marketing Research* 30: 305–314. doi:10.1177/002224379303000303.
Thurstone, L. L. 1927. "A Law of Comparative Judgment." *Psychological Review* 34: 273–286. doi:10.1037/h0070288.
Walsh, J. P., Y. N. Lee, and L. Tang. 2019. "Pathogenic Organization in Science: Division of Labor and Retractions." *Research Policy* 48: 444–461. doi:10.1016/j.respol.2018.09.004.
Wedel, M., and W. Kamakura. 2000. *Market Segmentation: Conceptual and Methodological Foundations*. Boston, MA: Kluwer Academic.

Appendix A. Example of a BWS choice set from Part A of the survey instrument

Question A1

Of the five researcher responsibilities shown below, please indicate the one responsibility ***out of those five*** that, you think, is **most** important responsibility of a researcher and the one responsibility ***out of those five*** that, you think, is **least** important responsibility of a researcher.

Appendix B. Questions from Parts B and C of the Survey Instrument

Question B1

Most Important	Researcher responsibility*	Least Important
	Adherence to Regulations	
	Research Findings	
	Authorship	
	Public Communication	
	Research Records	

*By hovering the cursor over the labels in this online survey, respondents could see the full descriptions of the responsibilities shown in Table 1.

Were you aware of the "Singapore Statement on the Integrity of Research" before you took part in this survey? If so, please indicate the main source through which you became aware of it.

- No.
- Yes; I heard about it through my university's communication outlets (newsletters and the like).
- Yes; I heard about it through a presentation/workshop at my university.
- Yes; I heard about it from a colleague at my university.
- Yes; I heard about it from a colleague at another university in my country.
- Yes; I heard about it from a colleague at a foreign university.
- Yes; I heard about it through another source; please specify: _____

Question B2

Are you aware of a national research code of conduct in your country ("National Code")?

- No.
- Yes, but the National Code is not publicized to researchers at my university.
- Yes, but while the National Code is publicized to researchers at my university, it is not given sufficient prominence.
- Yes, and the National Code is instilled among researchers at my university.

Question B3

Which of the following best describes your opinion about the effect on research integrity of a national research code of conduct?

- A National Code does *not* contribute to fostering research integrity.
- A National Code makes *some* contribution to fostering research integrity.
- A National Code makes a *major* contribution to fostering research integrity.
- I don't know if a National Code contributes to fostering research integrity.

Question B4

Are you aware of a research code of conduct at your university ("University Code")?

- No.
- Yes, but the University Code is not publicized to researchers at my university.
- Yes, but while the University Code is publicized to researchers at my university, it is not given sufficient prominence.
- Yes, and the University Code is instilled among researchers at my university.

Question B5

Which of the following best describes your opinion about the effect on research integrity of a university code of conduct?

- A University Code does *not* contribute to fostering research integrity.
- A University Code makes *some* contribution to fostering research integrity.
- A University Code makes a *major* contribution to fostering research integrity.
- I don't know if a University Code contributes to fostering research integrity.

Question B6

Are you aware of any staff training at your university regarding responsible conduct of research?

- No.
- Yes, and such staff training is mandatory.
- Yes, and such staff training is not mandatory.

Question B7

Which of the following best describes your opinion about the effect on research integrity of staff training regarding responsible conduct of research?

- Staff training regarding responsible conduct of research does *not* contribute to fostering research integrity.
- Staff training regarding responsible conduct of research makes *some* contribution to fostering research integrity.
- Staff training regarding responsible conduct of research makes a *major* contribution to fostering research integrity.
- I don't know if staff training regarding responsible conduct of research contributes to fostering research integrity.

Question B8

Do you have, or have you ever had, a research mentor?

- No.
- Yes, I have (had) a research mentor in both formal and informal mentoring relationships.
- Yes, I have (had) a research mentor, only in a formal mentoring relationship.
- Yes, I have (had) a research mentor, only in an informal mentoring relationship.

Question B9

Are you, or have you ever been, a research mentor?

- No.
- Yes, I am/have been a research mentor in both formal and informal mentoring relationships.
- Yes, I am/have been a mentor, only in a formal mentoring relationship.
- Yes, I am/have been a mentor, only in an informal mentoring relationship.

Question B10

Which of the following best describes your opinion about the effect of research mentoring on research integrity?

- Research mentoring does *not* contribute to fostering research integrity.
- Research mentoring makes *some* contribution to fostering research integrity.
- Research mentoring makes a *major* contribution to fostering research integrity.
- I don't know if research mentoring contributes to fostering research integrity.

Question B11

Do you feel there is normative peer pressure in your immediate research environment to conduct research with integrity?

- No.
- Yes, and if anyone were to breach the research integrity norms, they would be counseled *informally* by their peer(s).

- Yes, and if anyone were to breach the research integrity norms, they would be referred by their peers to be investigated *formally*.

Question B12

Which of the following best describes your opinion about the effect of normative peer pressure on research integrity?

- Normative peer pressure does *not* contribute to fostering research integrity.
- Normative peer pressure makes *some* contribution to fostering research integrity.
- Normative peer pressure makes a *major* contribution to fostering research integrity.
- I don't know if normative peer pressure contributes to fostering research integrity.

Question C1

Which discipline best describes your main area of research?

- Mathematical Sciences
- Physical Sciences
- Chemical Sciences
- Earth Sciences
- Biological Sciences
- Information, Computing and Communication Sciences
- Engineering and Technology
- Agricultural, Veterinary and Environmental Sciences
- Architecture, Urban Environment and Building
- Medical and Health Sciences
- Education
- Economics
- Commerce, Management, Tourism and Services
- Policy and Political Science
- Studies in Human Society
- Behavioral and Cognitive Sciences
- Law, Justice and Law Enforcement
- Journalism, Librarianship and Curatorial Studies
- The Arts
- Language and Culture
- History and Archeology
- Philosophy and Religion
- Other; please specify: _____

Question C2

Which of the following best describes your academic staff position?

- Postdoctoral staff
- (Associate) Lecturer/Assistant Professor
- Senior/Principal Lecturer
- (Associate) Professor/Reader
- Other: please specify: _____

Question C3

How many years of employment have you had within the university sector?

- < 5 years
- 5–10 years
- 11–15 years
- > 15 years

Question C4

When did you receive your last competitive research grant (whether solely or as part of a research team)?

- Between 2015 and 2018
- Between 2010 and 2014
- Before 2010
- I have never received a competitive research grant

Question C5

When was your last refereed research publication (whether sole-authored or multi-authored)?

- Between 2015 and 2018
- Between 2010 and 2014
- Before 2010
- I do not have a refereed research publication

Question C6

In which country are you currently employed? Please choose from the following list.