Challenges Faced by Early-Career Researchers in the Sciences in Australia and the Consequent Effect of those Challenges on their Careers: a Mixed Methods Project.

Katherine Ruth Christian
Bachelor of Science

Submitted in total fulfilment of the requirements for the degree of Doctor of Philosophy

School of Arts
Federation University Australia
PO Box 663
University Drive, Mount Helen
Ballarat Victoria 3353
Australia

January 12, 2021

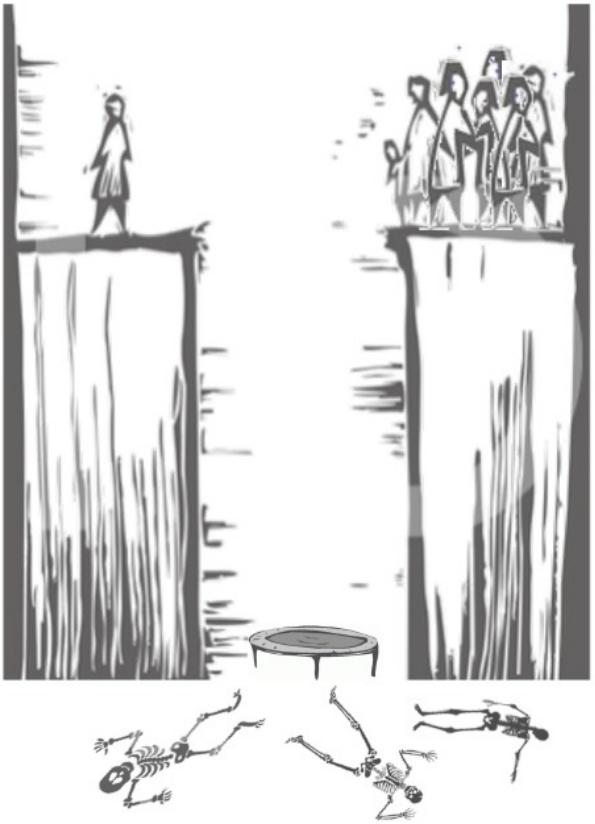


Image included with permission of Prof Don Newgreen

Table of Contents

List of Figures

List of Tables

Abstract

The purpose of the study was to explore the challenges faced by early-career researchers (ECRs) in the sciences in Australia and the consequent effect of those challenges on their careers. Using a realist/postpositivist paradigm, an evaluative approach, and a framework of job satisfaction, this project has explored and compared the views of ECRs to evaluate the factors which shape the ECR experience and contribute to job satisfaction or dissatisfaction and intention to leave, and to define the features which are necessary to keep an ECR in research.

Data collection for this mixed methods study entailed a national survey of researchers working in universities and research institutes (n=658), a focus group discussion and semi-structured in-depth interviews with eight women from a variety of scientific disciplines who had recently left academic research workplaces. I focussed particularly on the difficulties consequent to job insecurity: the constant need to attracting funding and a permanent position, lack of work-life balance and associated stress; and evidence of workplace difficulties such as bullying, harassment or inequity and support – or lack of it – offered by the research institutions. I examined the factors which contribute to and barriers which prevent job satisfaction of this population, and the consequent intention (if any) for ECRs to leave research or change their career path.

I found an interesting situation whereby the satisfaction derived from a "love of science" was counterbalanced by stress and poor working conditions which are a consequence of lack of job security, typified by poor supervision, bullying or harassment, inequitable hiring practices, a concerning rate of impact from "questionable research practices" (impacting 34%-41% of respondents) and evidence of very high (80%) intention of ECRs to leave their position. The most significant predictor of intention to leave is time as a

postdoctoral scientist: eventually the job insecurity and its associated stresses become too much and the ECRs leave their chosen career for work elsewhere. This decision, too, provides interesting findings as many of the ECRs have difficulty planning what to do next. They feel ill-prepared for an alternate career and suffer from a sense of failure as a result of having to leave academia.

While addressing the shortage of funding is outside the scope of this study, in addition to offering my findings I put forward a range of recommendations which could lead to a change of culture and benefit the wellbeing of ECRs in STEMM without incurring significant cost.

The Australian Government, higher education institutions and the research community need to improve job security and workplace conditions and take better care of our people in STEMM disciplines or we will not have the scientists we need to deliver the "innovative Australia" planned for 2030 (Department of Industry Innovation and Science, 2018)

Reference

Department of Industry Innovation and Science. (2018). Australia 2030: Prosperity through Innovation. Australian Government. https://www.industry.gov.au/data-and-publications/australia-2030-prosperity-through-innovation

Signed Declaration of Authorship page which should be Page xi has been removed

Publications During Enrolment

Christian, K., Johnstone, C., Larkins, J., & Wright, W. (2019, September 17). The need to seek institutional approval to survey staff –was this a misunderstanding of the purpose of Guideline 2.2.13 in the National Statement on Ethical Conduct in Human Research? Research Ethics Monthly. https://ahrecs.com/human-research-ethics/the-need-to-seek-institutional-approval-to-survey-staff-was-this-a-misunderstanding-of-the-purpose-of-guideline-2-2-13-in-the-national-statement-on-ethical-conduct-in-human-research

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. R. (2020a). Survey of Australian STEMM Early Career Researchers: Job insecurity and questionable research practices are major structural concerns. BioRxiv, 2020.02.19.955328. https://doi.org/10.1101/2020.02.19.955328. Published as a pre-print in February 2020; accepted, as an extended version, by eLife in December 2020 (see below).

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. (2020b, July 29). What are questionable research practices as reported by ECRs in STEMM in Australia? Research Ethics Monthly. https://ahrecs.com/uncategorized/what-are-questionable-research-practices-as-reported-by-ecrs-in-stemm-in-australia/

Christian K, Johnstone C, Larkins J, Wright W, Doran MR. A survey of early-career researchers in Australia. Rodgers P, Deathridge J, Lijek RS, Rolf H, Hussain T, editors. eLife. 2021 Jan 11;10:e60613 (extended version of BioRxiv pre-print above)

These publications are incorporated into the thesis within Chapters 3 and 4. Some material from within this thesis is reproduced in the eLife manuscript.

Two further publications are under review at the time of submission of this thesis and discuss matters covered in Chapters 5 and 6. These are:

Christian, K., Johnstone, C., Larkins, J. and Wright, W. “Why have Eight Researcher Women in STEMM Left Academic Research, and Where did They Go?”

Christian, K., Johnstone, C., Larkins, J. and Wright, W. **“**Why don’t early-career researchers undertake professional development?”

Declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

The core theme of the thesis is the challenges faced by early-career researchers in the sciences in Australia and consequences they have for their careers. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the Faculty of Arts under the supervision of Dr Carolyn Johnstone, A/Prof Wendy Wright and Jo-ann Larkins. A/Prof Michael Doran who contributed to two of the published works is a colleague with whom I have an active collaboration.

The inclusion of these co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of the published work included in Chapters 3 and 4 my contribution to the work involved the following:

Thesis Chapter	Publication Title	Status	Nature and % of student contribution	Co-author name(s) Nature and % of Co-author's contribution
3	The need to seek institutional approval to survey staff –was this a misunderstanding of the purpose of Guideline 2.2.13 in the National Statement on Ethical Conduct in Human Research?	Published	70%. Concept, collecting data and writing first draft	1) Carolyn Johnstone, concept and input into manuscript 10% 2) Jo-ann Larkins, concept and input into manuscript 10% 3) Wendy Wright, concept and input into manuscript 10%
4	A survey of early career researchers in Australia.	Published	65%. Concept, collecting data and writing first draft	1) Carolyn Johnstone, input into manuscript 5% 2) Jo-ann Larkins, input into manuscript 5% 3) Wendy Wright, input into manuscript 5% 4) Michael Doran 20% concept and input into manuscript.
4	What are questionable research practices as reported by ECRs in STEMM in Australia?	Published	75%. Concept, collecting data and writing first draft	1) Carolyn Johnstone, input into manuscript 5% 2) Jo-ann Larkins, input into manuscript 5% 3) Wendy Wright, input into manuscript 5% 4) Michael Doran 10% concept and input into manuscript.

Additional Publications by the Candidate Relevant to the Thesis but not Forming Part of it

Christian, K. (2018). Keys to Running Successful Research Projects: All the Things They Never Teach You (1st ed.). Academic Press. https://www.elsevier.com/books/isbn/9780128131343

Papers which have Cited Publications Included in this Thesis

Climie, R. E., Wu, J. H. Y., Calkin, A. C., Chapman, N., Inglis, S. C., Colafella, K. M. M., Picone, D. S., Tan, J. T. M., Thomas, E., Viola, H. M., Wise, S. G., Murphy, A. J., Nelson, M. R., Nicholls, S., Hool, L. C., Doyle, K., Figtree, G. A., & Marques, F. Z. (2020). Lack of Strategic Funding and Long-Term Job Security Threaten to Have Profound Effects on Cardiovascular Researcher Retention in Australia. Heart, Lung and Circulation, 0(0). https://doi.org/10.1016/j.hlc.2020.07.010

Journals Responding to a Publication in this Thesis

(in all cases responding to BioRxiv pre-print (Christian et al., 2020a))

Nature News (Woolston, 2020a)
https://www.nature.com/articles/d41586-020-00687-0

Royal Society of Chemistry magazine, Chemistry World (Dalmeet Singh Chalwa, 2020)
https://www.chemistryworld.com/news/questionable-research-practices-are-hurting-junior-researchers/4011250.article

Nature Index (Conroy, 2020)
https://www.natureindex.com/news-blog/heres-why-so-many-young-researchers-want-to-quit-in-five-graphs

Nature Index (Dalmat Singh Chalwa, 2020)
https://www.natureindex.com/news-blog/its-time-to-get-serious-about-research-fraud

Blog Items Published in Response to the Publications in this Thesis

(in all cases responding to BioRxiv pre-print (Christian et al., 2020a))

PreLights (PreLights, 2020)
Inclusion of link to the pre-print and comments
https://prelights.biologists.com/highlights/survey-of-australian-stemm-early-career-researchers-job-insecurity-and-questionable-research-practices-are-major-structural-concerns/

The Node
Inclusion of link to the pre-print
https://thenode.biologists.com/february-in-preprints-4/highlights/ (in Research Practice and Education)
https://thenode.biologists.com/june-in-preprints-5/highlights/ (in Research Practice and Education)

Two mentions of preprint in Retraction Watch
https://retractionwatch.com/2020/02/22/weekend-reads-an-editor-wonders-whether-data-exist-how-universities-cover-up-scientific-fraud-detecting-paper-mills/

https://retractionwatch.com/2020/03/07/weekend-reads-a-whistleblower-is-fired-problems-in-heart-research-doing-the-right-thing-in-science/

Twitter
Inclusion of pre-print in "Journal club" of The International Centre for the Study of Research
https://twitter.com/carey_mlchen/status/1284145582164946944

Acknowledgements

My candidature has been supported by an Australian Government Research Training Program (RTP) Fee-Offset Scholarship through Federation University Australia.

First and foremost, I thank my wonderful supervisory team Dr Carolyn Johnstone, Mrs Jo-ann Larkins and A/Prof Wendy Wright for accepting me as a doctorate student and guiding me in my research. I especially thank them for their patience in inducting me, someone from the world of medical research, into the very different language and methods of the social sciences.

I particularly thank, too, all those people who must remain anonymous, but who gave their time and took part in the focus group, completed the pilot on-line survey and made helpful comments, took part in the interviews and participated in the on-line survey and thus helped me create and collect my research data.

I was fortunate to receive support and encouragement in a variety of ways from:

- Dr Eva Altinic
- Prof Pat Bazeley
- Prof Sharon Bell
- Dr Joyce Burcham
- Bronwyn Carroll
- A/Prof Michael Doran
- Dr Kathryn Futrega
- Floyd Larsen
- Prof Adrian Lee
- Prof Clare Scott

- A/Prof Freddy Sitas

and many of my friends and colleagues in the broad world of medical research.

I thank the people and organisations who assisted with distribution of the on-line survey invitation but especially:

- Anna Ahveninen, Royal Australian Chemical Institute
- Christine Anderson, University of Sydney
- Dr Marc Duldig, Astronomical Society of Australia
- Dr Wafa El-Adhami, Executive Director, Science in Australia Gender Equity, (SAGE)
- A/Prof Drew Evans, EMCR Forum
- Dr Melanie Haines, University of Canberra
- Nadia Levin, Research Australia
- A/Prof Francine Marques Baker Heart and Diabetes Institute
- Laura Navarro EMCR Forum
- Dr Jana Phan, Australian Academy of Science
- Dr Kyle Ratinac and Dr Rachel Yuen-Collingridge, Macquarie University
- Prof John Rice, Australian Council of Deans of Science
- Dr Kim Rickard, Professional Scientists Australia
- Dr Peter Thomas, Australian Association of Medical Research Institutes
- Australian Society for Medical Research
- Franklin Women
- Science and Technology Australia
- Women in STEM

I acknowledge and thank the many people at Federation University Australia who have assisted me throughout my candidature, but especially:

- Paula Di Maria
- Fiona Koop
- Dr Rob Watson
- Jaimee Westin
- Roberta West
- IT department

Last, and by no means least, I acknowledge the patient support from my family on whom this work has had the greatest impact.

Glossary, including Acronyms and Abbreviations

ASA

Australian Science Academy

Early-Career Researcher (ECR)

An early-career researcher, (ECR), usually between 30 and 40 years old is defined as a postgraduate researcher of any discipline actively pursuing a research career, without yet being fully established.

The ECRs for this work are ECRs who are involved in research within all scientific disciplines at universities and research institutes in Australia. The ECR will have received a doctoral level qualification (such as a PhD) up to 10 years ago.

Although the term ECR is widely used, its definition varies. This research uses a definition consistent with the National Health and Medical Research Council's (NHMRC) "New Investigators" category. Other researchers also consider ECRs to include doctoral students together with researchers who completed their PhD within the past 10 years and do not hold a permanent position (Bell et al., 2016; Geffers, 2017; Handel & Knight, 2017). Sometimes an early-career researcher is defined simply as "younger than 40" (Bos, Langer, & Flood, 2017). The Australian Early- and Mid-Career Researcher Forum defines "emerging scientists" slightly more broadly, as researchers who are up to 15 years post-PhD (or other research higher degree), irrespective of their professional appointment. Internationally, the Global Young Academy (GYA) represents all scholars working in any research-based discipline, including the sciences, medicine, engineering, social sciences, the arts and humanities in the early years of their independent careers. The majority of the GYA's members are aged 30-40 and the typical period from completion of a PhD or similar degree is 3-10 years.

Early and Mid Career Forum (EMCR Forum)

A representative network of early- and mid-career researchers, an initiative of the Australian Academy of Science

GYA

Global Young Academy

HDR Student

Higher degree research student

HREC

Human Research Ethics Committee

Intention to Leave

The intent to leave or stay in a work position.

Job Satisfaction

Two common, and certainly similar, definitions describe job satisfaction. One: "the pleasurable emotional state resulting from the appraisal of one's job as achieving or facilitating the achievement of one's job values" (Locke, 1976). Two (preferred): the extent to which people like (satisfaction) or dislike (dissatisfaction) their jobs" (Spector, 1997).

Principal Investigator (PI)

The term "principal investigator" (PI) refers to the holder of an independent grant and the lead researcher for the grant project, usually in the sciences, such as a laboratory study or a clinical trial (National Cancer Institute, 2011). Though sometimes PIs themselves, ECRs in this project will often be supervised by a PI.

Postdoctoral Researcher

There is no consistent definition of postdoctoral researchers (Åkerlind, 2005) however for the purposes of this study we define it in its simplest form as a person professionally conducting research after the completion of their doctoral studies (typically a PhD). Postdoctoral researchers typically work under the supervision of a principal investigator. In many English-speaking countries, postdoctoral researchers are colloquially referred to as "postdocs". In this thesis I more commonly use the expression ECR, as defined above.

Postdocs

As mentioned above, postdoctoral researchers typically work under the supervision of a principal investigator. In many English-speaking countries, postdoctoral researchers are colloquially referred to as "postdocs".

Researchers

Researchers referred to in this thesis are described, interchangeably, as “researcher”, “scientist” and “academic”.

Science in Australia Gender Equity (SAGE)

SAGE is an Australian gender equity and diversity organisation aiming to achieve meaningful systemic and cultural change within organisations by using a proven national accreditation framework. SAGE is supported by the Australian Government.

SEM

Structural equation modelling

STEM

A grouping of several fields of research and/or academic endeavour: science, technology, engineering and mathematics.

STEMM

A grouping of several fields of research and/or academic endeavour: science, technology, engineering, mathematics and medicine. “STEMM” and “STEM” are used almost interchangeably throughout this thesis. When used without the M for medicine it is likely that the matter under discussion is not as relevant for ECRs working in medical research.

Chapter 1|

Introduction to and Justification for the Study

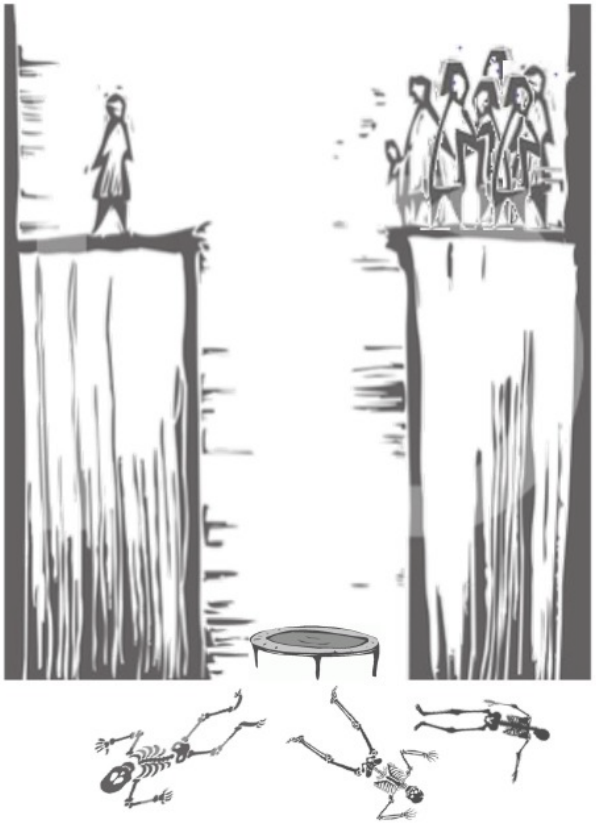


Image included with permission of Prof Don Newgreen

This chapter presents the introduction and justification for the study which examines the supports and barriers for job satisfaction of early-career researchers (ECRs) in the sciences in Australia. This chapter includes the research questions and study aims and an outline of the thesis and provides context for the project.

1.1 Introduction to the PhD Candidate

I have been working in research management, mostly in medical research, for almost 30 years. Until early 2020 I was Research Program Manager for a not-for-profit body which funds ECRs for medical research; prior to that I was Manager of the Research Division of Cancer Council NSW for many years where many of our researchers were "early-career". I am currently Training Manager for a Centre of Research Excellence in respiratory health where, again, I work with a group of ECRs. In these and prior positions I have worked with ECRs across a number of health and medical disciplines, working, myself, both as a researcher and manager of researchers. I am author of a book about research management, targeted at ECRs (Christian, 2018) which I wrote from the basis of my long experience of helping ECRs establish their research careers. I thus have a long-held interest in ECRs and take an "insider" approach to my research (Greene, 2014). While I am not an ECR as defined in the project, I have been closely involved with these ECRs on a day-to-day basis and acknowledge the biases this close association might have brought.

My career path has caused me to become very familiar with the National Statement on Ethics (National Health and Medical Research Council, 2018b) and its requirements, with the Australian Code of Responsible Conduct of Research (Australian Research Council & Universities Australia, 2018), and with asking questions, via both questionnaires and interviews. Prior to my career in medical research, I was involved for several years in the early years of market research in Australia following my Bachelor of Science in Chemistry.

While I am thus very familiar with the practice of the techniques and processes used in social science (interviews, surveys, focus groups), I had had limited exposure through my work to social science and none at all to academic social science. While most of the content from my book came from my personal management experience in research workplaces, research for this book for STEMM academics was again not conducted in a social science environment.

This combination of long experience in the world of ECRs, and of thoroughly knowing and understanding the environment I was researching, with lack of experience in academic social science has provided challenges both for me and my supervisors throughout my studies.

1.1.1 Link from my Experience to the Project

During my career in medical research and the administration of medical research it has been apparent that ECRs across the scientific disciplines exist in a very difficult environment. There is insufficient funding available for the sector, and there is minimal job security for most (Bell & Yates, 2015; Hardy et al., 2016; Walton, 2016). The situation for ECRs is getting worse as the funding pool decreases (National Health and Medical Research Council, 2016) and the number of postdoctoral researchers seeking positions increases (Department of Education, Australian Government, 2019; McCarthy & Wieke, 2019). My work has brought me into contact with a very large number of researchers working in institutions across Australia. I have been aware of many ECRs of my acquaintance struggling with difficult circumstances. I chose to embark on this project in order to objectively examine the situation across all science disciplines, with a view to identifying ways to improve the situation. Publications and ability to attract funding are the measures of success in STEMM research. Generally, one cannot have a research position without funding, as there are no secure

positions in research, so there is constant and ongoing pressure to publish and to attract this funding. The pressure has become overwhelming (Herbert et al., 2014; Susi et al., 2019; Winefield et al., 2008).

My observation has been that little if any effort is made by the ECRs to focus on anything other than academic research as a career path, (or, more accurately, on their actual current research and its results), so overall professional development is neglected. In parallel, there is little apparent effort made by institutions to support the readily available pool of researchers for a long-term career in academia, or to prepare them for a science career elsewhere.

While my personal experience has been in medical research, mostly cancer research, it is interesting to note that the difficulties experienced by ECRs discussed in the literature appear to be the same for those in fields as disparate as conservation, geology, oceanography, nursing, and for clinician-researchers in all fields of medicine (Abbott, 2013; Åkerlind, 2005; Chapman et al., 2015; Liang et al., 2019; Walton et al., 2018; Warner, 2007).

Ultimately, my findings discussed in Chapters 4, 5 and 6 have confirmed that the circumstances I had identified through my experience in cancer research were replicated elsewhere; these findings indicate conditions in many work environments are significantly worse than I had expected.

1.2 Introduction to the Project

There is a shortage of funding for scientific research in Australia which colours the background for the early-career researchers. This is not a new problem. It was addressed by Australian Research Council (ARC) in a commissioned report in 1996 (Bazeley et al., 1996) which found that the increasing pressure of competition for grants awarded by the ARC had

led to an unsatisfactorily low success rate (30-35%) with a discouraging effect on early-career researchers. The report notes: “Concern has therefore been expressed that researchers of promise are being lost, and that disciplines will consequently suffer in terms of their future development.” (Bazeley et al., 1996, p ix).

The situation described above remains true today, only it is much worse: the success rate for research grant applications which caused this concern in 1996 has since halved. In Australia, success rates for NHMRC project grants, for example, have reduced from 25% 20 years ago to about 12% today (depending on the scheme; 13% success rate for NHMRC Investigator Grants in 2020) and the average age of successful applicants has increased from early 30’s to early 50’s (Hardy et al., 2016; National Health and Medical Research Council, 2016). This decrease in success rates is most striking for the project grants scheme; marked falls in funding rates have also occurred for NHMRC Early Career, Career Development and Research Fellowships. Absolute numbers of grants and fellowships awarded each year have also now fallen. As noted by Bazeley in 1996, this low funding rate particularly affects early-career scientists who are often entirely dependent on attracting grant funding for both their salary and their research funding (Hardy et al., 2016; Kavallaris, 2008; Phillips & Meacham, 2015). Grant writing has been shown to take up very substantial proportion of time in a researcher’s year and has significant negative impact on researchers’ personal lives, health and well-being (Herbert et al., 2014); this is typically a very high investment of time for a low return particularly as that precious time could be spent on actually doing the research. Researchers say “the cost of writing proposals is too high given the limited chance of success in a system they regard as overly competitive" (Gascoigne, 2012, p.68).

Thanks to the Australian Government’s efforts in investment in Science, Technology, Engineering, Mathematics and Medicine (STEMM) education (Department of Industry,

Innovation and Science, 2017; McCarthy & Wieke, 2019; McKeon et al., 2013; National Health and Medical Research Council, 2016, 2017a) there are more and more PhD students in STEMM (McCarthy & Wieke, 2019). Young scientists are generally training for a career in research because they love it (Gascoigne, 2012; Wellcome Trust, 2020), but it seems that in their early postdoctoral years they often become very discouraged due to the extreme pressures to publish and attract funding (Bentley et al., 2013; Gascoigne, 2012; Grinstein & Treister, 2018). There is little job security (Bell & Yates, 2015; National Health and Medical Research Council, 2020; Phillips & Meacham, 2015). There is little further investment in these expensively trained young scientists within their postdoctoral environment (Bell & Yates, 2015). Ultimately, Australia loses many of its early-career researchers (ECRs) because they either leave research or go to another country where they have greater job security (Australian Society of Medical Research, 2016; Petersen, 2011).

This situation for ECRs in Australia is similar in many other countries (Maher & Anfres, 2016; Miller & Feldman, 2015; National Health and Medical Research Council, 2016, 2017a). While there is evidence in the literature about the range of difficulties faced by ECRs in the sciences internationally, there is only limited data about the situation in Australia for ECRs in STEMM. Most research which has been conducted in Australia is about ECRs across all disciplines; that which is about STEMM researchers focuses on the lack of funding and its consequences and there has been little apparent effort made to understand or improve the research workplace against this background of limited funding. Similarly, there has been little research on professional development or other workplace support for ECRs, or on their job satisfaction. The notable contributions have included the work of Browning et al. (2011, 2014, 2016, 2017) who have a particular interest in researcher development; more theoretical work on researcher careers by Bazeley (Bazeley et al., 1996; Bazeley, 1999, 2003), Laudel & Gläser (2008) and the work of Coates et al. (Coates et al., 2008, 2015; Coates &

Goedegebuure, 2010, 2012), and Thompson et al. (2001) and Åkerlind (2005, 2008) who have long shared concerns about the career prospects of researchers in Australia. Although these works share in part the same area of interest of this work, none addresses the difficulties of ECRs in the sciences across Australia as a whole, or in the same breadth as in this project. Browning and colleagues focus on professional development for ECRs; Coates and colleagues share a concern about job satisfaction for academics at large; Laudel and Glaser take a theoretical approach, "positioning the early career phase in a theoretical framework that combines the approaches from the sociology of science and organizational sociology and emphasizes the transitional process" (Laudel & Glaser, 2008, p. 387). Bazeley et al. (1996) and then Thompson et al. (2001) and Akerlind (2005) do have some similarities to the proposed work, but are about academics across all disciplines and are reflective of times between 12 and 24 years ago when the funding success rates were a little higher.

When examining researcher development, previous researchers have focussed more fully on the doctoral environment than on the workplace environment for ECRs (Edwards et al., 2011; McGagh et al., 2016). There are few studies on the supports and barriers to researcher development for early-career researchers in STEMM; it is not known why this is the case.

Against this background of limited funding, this project has aimed to fill the gaps in understanding of the workplace environment for ECRs in STEMM in Australia and has examined, by querying factors known or suspected to be contributors to job satisfaction, the satisfaction – or lack of satisfaction - of ECRs, and their relationship to intention to leave the scientific environment.

This work focusses on people up to 10 years postdoctoral ("early-career" as defined by the National Health and Medical Research Council (NHMRC) until 2018 and in common

practice in the literature (Bell & Yates, 2015; Friesenhahn & Beaudry, 2014; Geffers et al., 2017)) and employed in research at universities and research institutes in Australia. People employed in private enterprise/industry or government institutes and non-government organisations have been excluded as their environment is different.

Using a realist/postpositivist paradigm (Guba & Lincoln, 1994; Howes, 2017), an evaluative approach, and a framework of job satisfaction, this project explores and compares the views of ECRs to evaluate the factors which shape the ECR experience and contribute to job satisfaction or dissatisfaction and intention to leave, and perhaps define the features which are necessary to keep an ECR in research. The approach to the project is discussed in full in Chapter 3, however with respect to the conceptual framework, this project examines challenges faced by ECRs using a variation of frameworks for job satisfaction for people in academia developed by Rosser (2004) and Basak & Govender (2015). Information was sought about factors believed to contribute to job satisfaction and also to work motivation and intention to leave; the focus is on mentoring, career planning, training and professional development, work life balance and occupational stress and gender inequity.

This is a mixed methods project. The largely quantitative data collected in a national on-line survey was supported by qualitative data in open-ended survey responses and data collected via a focus group, in-depth interviews with ECRs who have recently left academic research, and journal entries which reflected thoughts collected while actively undertaking the research and also in the course of my work which involves training and mentoring of ECRs in the sciences.

1.3 Purpose of the Study

The purpose of the study was to explore the challenges faced by early-career researchers in the sciences in Australia and the consequent effect of those challenges on their careers. I focussed particularly on the difficulties consequent to the need to attracting funding and a permanent position; lack of work-life balance and associated stress; evidence of bullying or harassment; evidence of inequity, be it gender or racial or other; difficulties experienced by and support offered for parents of young families. I have examined the factors which contribute to and barriers which prevent job satisfaction of this population, and the consequent intention (if any) for ECRs to leave research or change their career path. I was interested in any proposed alternative career if there is an intention to leave; in professional development opportunities offered and taken up and whether there are mentoring opportunities and whether mentoring contributes to job satisfaction and success.

The literature shows that in spite of the Australian Government's mandate to build the STEMM workforce (Department of Industry, Innovation and Science, 2017; Department of Industry Innovation and Science, 2018; National Health and Medical Research Council, 2018a), we continue to lose many of our ECRs, particularly women, out of science and often out of the country (Bazeley et al., 1996; Bell & Yates, 2015; Hardy et al., 2016; National Health and Medical Research Council, 2016, 2017b; Phillips & Meacham, 2015; Winchester & Browning, 2015). My aim in analysing and interpreting the data was to identify the most significant factors which contribute to the ECR environment (Chapter 4), and to job satisfaction/dissatisfaction and intention to leave (Chapter 5). In Chapter 6 I have summarised my findings and included some others which did not align with the themes of the earlier chapters. I have also provided suggestions for improvement of the work environment and job

satisfaction of these ECRs so that they are encouraged to return the investment made in their education and remain working in science in Australia.

Identifying ways to solve the lack of funding is well beyond the scope of this work. In Chapter 6 the work identifies some realistic and achievable ways in which the environment for ECRs could be improved and which can be considered by research institutions. Implementation of the recommendations will encourage well-prepared and supported ECRs to stay in research or take up alternative science-related careers in Australia. Specifically, the results of this work will influence and inform institutional management of ECRs by:

- Providing knowledge about the contributors or barriers to job satisfaction for ECRs
- Providing understanding about reasons why ECRs leave the scientific environment of universities and research institutes in Australia, or science altogether
- Identifying the specific features that shape the ECR experience and environment of the researcher who stays, and
- Identifying what may help to overcome the challenges or provide ECR satisfaction in spite of the challenges

1.4 Research Questions

In order to explore the topic "Challenges faced by early-career researchers in the sciences in Australia and the consequent effect of those challenges on their careers" I have posed the research question "What are the relationships between ECR job satisfaction or dissatisfaction and their likelihood of staying in science?" with sub-questions:

- What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?
- What are the motivations for ECRs leaving the sciences?
- What are the specific features of the experiences and environment of those ECRs who remain in the sciences?

1.5 Organisation of the Thesis

This is a thesis incorporating one manuscript and two shorter peer-reviewed blog articles. Consequently, the thesis document provides the "infrastructure" which links those papers; together the publications and the thesis respond to the research questions.

Chapter 1 provides the introduction, rationale, background and context for the study; Chapter 2 holds the literature review; Chapter 3 covers the research design, methodology and methods and is supported by a published article (Christian et al., 2019) which, in the section regarding participant recruitment, questions the need for institutional approval to do so. Chapter 4 presents the results regarding job satisfaction, and evidence of many problems which are further explained in the eLife manuscript (Christian et al., 2021) and the published article Christian et al. (2020a) and presents a tool for modelling job satisfaction. Chapter 5 addresses the motivations for ECRs to leave the academic research workplace. Chapter 6 includes some results about professional development, highlights the findings and the new work identified by the project and brings together the recommendations for change.

Chapter 1 References

Abbott, M. (2013). Early Career Scientists: Funding and Publishing Challenges. Oceanography, 26(4), 7–7. https://doi.org/10.5670/oceanog.2013.83

Åkerlind, G. S. (2005). Postdoctoral researchers: Roles, functions and career prospects. Higher Education Research & Development, 24(1), 21–40. https://doi.org/10.1080/0729436052000318550

Åkerlind, G. S. (2008). An academic perspective on research and being a researcher: An integration of the literature. Studies in Higher Education, 33(1), 17–31. https://doi.org/10.1080/03075070701794775

Australian Research Council, & Universities Australia. (2018). National Health and Medical Research Council: The Australian Code for the Responsible Conduct of Research.

Australian Society of Medical Research. (2016). The 2016 ASMR Health and Medical Research Workforce Survey. Australian Society of Medical Research. https://asmr.org.au/wp-content/uploads/library/Workforce16.pdf

Basak, S. K., & Govender, D. (2015). Theoretical Framework Of The Factors Affecting University Academics Job Satisfaction. International Business & Economics Research Journal (IBER), 14(2). https://doi.org/10.19030/iber.v14i2.9167

Bazeley, P., Kemp, L., Stevens, K., Asmar, C., Grbich, C., Marsh, H., & Bhathal, R. (1996). Waiting in the Wings: A Study of Early Career Academic Researchers in Australia. Australian Research Council and National Board of Employment Education and Training (NBEET). https://trove.nla.gov.au/version/217785130

Bazeley, Pat. (1999). Continuing Research by PhD Graduates. Higher Education Quarterly, 53(4), 333–352. https://doi.org/10.1111/1468-2273.00135

Bazeley, Pat. (2003). Defining 'Early Career' in Research. Higher Education, 45(3), 257–279. https://doi.org/10.1023/A:1022698529612

Bell, S., & Yates, L. (2015). Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne. https://womeninscienceaust.org/2014/06/15/women-in-the-scientific-research-workforce-identifying-and-sustaining-the-diversity-advantage/

Bentley, P., Coates, H., Dobson, I., Goedegebuure, L., & Meek, V. L. (2013). Factors associated with job satisfaction amongst Australian university academics and future workforce implications. In Job Satisfaction around the Academic World. https://link.springer.com/chapter/10.1007/978-94-007-5434-8_3

Browning, L., Thompson, K., & Dawson, D. (2011). Developing the next generation of research leaders: Understanding the path to shaping the future. Acta Academica Supplementum.

Browning, L., Thompson, K., & Dawson, D. (2014). Developing future research leaders: Designing early career researcher programs to enhance track record. International Journal for Researcher Development, 5(2), 123–134. https://doi.org/10.1108/IJRD-08-2014-0019

Browning, L., Thompson, K., & Dawson, D. (2016). It takes a village to raise an ECR: Organisational strategies for building successful academic research careers. International Journal for Researcher Development, 7(2). www.emeraldinsight.com/2048-8696.htm

Browning, L., Thompson, K., & Dawson, D. (2017). From early career researcher to research leader: Survival of the fittest? Journal of Higher Education Policy and Management, 39(4), 361–377. https://doi.org/10.1080/1360080X.2017.1330814

Chapman, J. M., Algera, D., Dick, M., Hawkins, E. E., Lawrence, M. J., Lennox, R. J., Rous, A. M., Souliere, C. M., Stemberger, H. L. J., Struthers, D. P., Vu, M., Ward, T. D., Zolderdo, A. J., & Cooke, S. J. (2015). Being relevant: Practical guidance for early

career researchers interested in solving conservation problems. Global Ecology and Conservation, 4, 334–348. https://doi.org/10.1016/j.gecco.2015.07.013

Christian, K. (2018). Keys to Running Successful Research Projects: All the Things They Never Teach You (1st ed.). Academic Press. https://www.elsevier.com/books/isbn/9780128131343

Christian, K., Johnstone, C., Larkins, J., & Wright, W. (2019, September 17). The need to seek institutional approval to survey staff –was this a misunderstanding of the purpose of Guideline 2.2.13 in the National Statement on Ethical Conduct in Human Research? Research Ethics Monthly. https://ahrecs.com/human-research-ethics/the-need-to-seek-institutional-approval-to-survey-staff-was-this-a-misunderstanding-of-the-purpose-of-guideline-2-2-13-in-the-national-statement-on-ethical-conduct-in-human-research

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. (2020a, July 29). What are questionable research practices as reported by ECRs in STEMM in Australia? Research Ethics Monthly. https://ahrecs.com/uncategorized/what-are-questionable-research-practices-as-reported-by-ecrs-in-stemm-in-australia/

Christian K, Johnstone C, Larkins J, Wright W, Doran MR. A survey of early-career researchers in Australia. Rodgers P, Deathridge J, Lijek RS, Rolf H, Hussain T, editors. eLife. 2021 Jan 11;10:e60613

Coates, H., & Goedegebuure, L. (2010). The Real Academic Revolution: Why we need to reconceptualise Australia's future academic workforce. L H Martin Institute. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0007/2565070/Why-we-need-to-reconceptualise-Australias-future-academic-workforce.pdf

Coates, H., & Goedegebuure, L. (2012). Recasting the academic workforce: Why the attractiveness of the academic profession needs to be increased and eight possible

strategies for how to go about this from an Australian perspective. Higher Education, 64(6), 875–889.

Coates, H., Goedegebuure, L., & Meek, V. L. (2015). Increasing the Attractiveness of the Academic Profession: A Challenge for Management. In U. Teichler & W. K. Cummings (Eds.), Forming, Recruiting and Managing the Academic Profession (pp. 297–315). Springer International Publishing. https://doi.org/10.1007/978-3-319-16080-1_16

Coates, H., Goedegebuure, L., Van der Lee, J., & Meek, L. (2008). The Australian academic profession in 2007: A first analysis of the survey results. Australian Council for Educational Research.

Department of Education, Australian Government. (2019, June 4). Higher Education Statistics, Department of Education, Australian Government. https://www.education.gov.au/higher-education-statistics

Department of Industry, Innovation and Science. (2017). Australia's National Science Statement. Commonwealth of Australia. http://science.gov.au/NSS

Department of Industry Innovation and Science. (2018). Australia 2030: Prosperity through Innovation. Australian Government. https://www.industry.gov.au/data-and-publications/australia-2030-prosperity-through-innovation

Edwards, D., Bexley, E., & Richardson, S. (2011). Regenerating the Academic Workforce. The careers, intentions and motivations of higher degree research students in Australia. Findings of the National Research Student Survey. Australian Council for Educational Research. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0009/1490940/RAW_Combined.pdf

Friesenhahn, I., & Beaudry, C. (2014). Global State of Young Scientists Project Report and Recommendations. Global Young Academy. https://globalyoungacademy.net/wp-content/uploads/2015/06/GYA_GloSYS-report_webversion.pdf

Gascoigne, T. (2012). Career support for researchers: Understanding needs and developing a best practice approach. Australian Council of Learned Academies Commissioned by the Department of Industry, Innovation, Science, Research and Tertiary Education.

Geffers, J., Beaudry, C., Yang, H.-C., Huang, F., Phanraksa, O., & Dominik, M. (2017). Global State of Young Scientists (GloSYS) in ASEAN: Creativity and Innovation of Young Scientists in ASEAN [Report]. Global Young Academy.

Greene, M. J. (2014). On the Inside Looking In—Methodological Insights and Challenges in conducting qualitative insider research. The Qualitative Report, 19(29). https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1106&context=tqr

Grinstein, A., & Treister, R. (2018). The unhappy postdoc: A survey based study. F1000Research, 6, 1642. https://doi.org/10.12688/f1000research.12538.2

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In Handbook of Qualitative Research (pp. 105–117). Sage Publications, Inc.

Hardy, M. C., Carter, A., & Bowden, N. (2016). What do postdocs need to succeed? A survey of current standing and future directions for Australian researchers. Palgrave Communications, 2, 16093. https://doi.org/10.1057/palcomms.2016.93

Herbert, D. L., Coveney, J., Clarke, P., Graves, N., & Barnett, A. G. (2014). The impact of funding deadlines on personal workloads, stress and family relationships: A qualitative study of Australian researchers. BMJ Open, 4(3), e004462. https://doi.org/10.1136/bmjopen-2013-004462

Howes, L. M. (2017). Developing the Methodology for an Applied, Interdisciplinary Research Project: Documenting the Journey Toward Philosophical Clarity. Journal of

Mixed Methods Research, 11(4), 450–468. https://doi.org/10.1177/1558689815622018

Kavallaris, M. (2008). Perceptions in health and medical research careers: The Australian Society for Medical Research Workforce Survey. Medical Journal of Australia, 188, 520–524.

Laudel, G., & Gläser, J. (2008). From apprentice to colleague: The metamorphosis of early career researchers. Higher Education, 55(3), 387–406. https://doi.org/10.1007/s10734-007-9063-7

Liang, R., Dornan, T., & Nestel, D. (2019). Why do women leave surgical training? A qualitative and feminist study. The Lancet, 393(10171), 541–549. https://doi.org/10.1016/S0140-6736(18)32612-6

Maher, B., & Anfres, M. S. (2016). Under Pressure. Nature, 538, 444–445.

McCarthy, P. X., & Wieke, M. (2019). Advancing Australia's Knowledge Economy. University of Melbourne on behalf of AMSI and CSIRO Data61's Ribit net. https://amsi.org.au/publications/advancing-australias-knowledge-economy/

McGagh, J., Marsh, H., Western, M., Thomas, P., Hastings, A., Mihailova, M., & Wenham, M. (2016). Review of Australia's Research Training System: Final Report. Australian Council of Learned Academies.

McKeon, S., Alexander, E., Frazer, I., Ferris, B., Brodaty, H., & Little, M. (2013). Strategic Review of Health and Medical Research – Better Health Through Research. Australian Government, Department of Health and Aging.

Miller, J. M., & Feldman, M. P. (2015). Isolated in the Lab: Examining Dissatisfaction with Postdoctoral Appointments. The Journal of Higher Education, 86(5), 697–724. https://doi.org/10.1353/jhe.2015.0029

National Health and Medical Research Council. (2016). Consultation Paper Structural Review. NHMRC.

National Health and Medical Research Council. (2017a). Consultation Summary Report. NHMRC.

National Health and Medical Research Council. (2017b). Funding Top Female Researchers.

National Health and Medical Research Council. (2018a). National Health and Medical Research Council Corporate Plan 2017–18. National Health and Medical Research Council.

National Health and Medical Research Council. (2018b). National Statement on Ethical Conduct in Human Research (2007)—Updated 2018. Commonwealth of Australia, Canberra. https://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018

National Health and Medical Research Council. (2020). 2019 Survey of research culture in Australian NHMRC-funded institutions. https://www.nhmrc.gov.au/research-policy/research-quality#download

Petersen, E. B. (2011). Staying or going? Australian early career researchers' narratives of academic work, exit options and coping strategies. Australian Universities Review, 53, 34–42.

Phillips, P., & Meacham, S. (2015). Submission to: Review of Australia's Research Training System. ASMR.

Rosser, V. J. (2004). Faculty Members' Intentions to Leave: A National Study on Their Worklife and Satisfaction. Research in Higher Education, 45(3), 285–309. https://doi.org/10.1023/B:RIHE.0000019591.74425.f1

Susi, T., Shalvi, S., & Srinivas, M. (2019). 'I'll work on it over the weekend': High workload and other pressures faced by early-career researchers. Nature. https://doi.org/10.1038/d41586-019-01914-z

Thompson, J., Pearson, M., Akerlind, G., Hooper, J., & Mazur, N. (2001). Postdoctoral training and employment outcomes. Department of Education, Training and Youth Affairs.

Walton, C. (2016). Best and Brightest—Advancing Medical Research—2016 Medical Research Institute Sector Survey Report. Professional Scientists Australia. http://www.professionalsaustralia.org.au/mri/advocacy/campaigns/medical-researchers/

Walton, C., Walker, K., & Porter, R. (2018). Professional Scientists Employment and Remuneration Report. Professionals Australia. http://www.professionalsaustralia.org.au/financial-edge/salary-survey-reports/scientists5/

Warner, J. (2007). Transferable skills are worthless if no new posts are created. Nurs Times, 102(50), 10.

Wellcome Trust. (2020). What researchers think about the culture they work in. Wellcome Trust. https://wellcome.org/reports/what-researchers-think-about-research-culture

Winchester, H., & Browning, L. (2015). Gender equality in academia: A critical reflection. Journal of Higher Education Policy and Management, 37(3), 269–281. https://doi.org/10.1080/1360080X.2015.1034427

Winefield, A. H., Boyd, C., Saebel, J., & Pignata, S. (2008). Job stress in university staff: An Australian research study. Australian Academic Press.

Chapter 2|

Literature Review

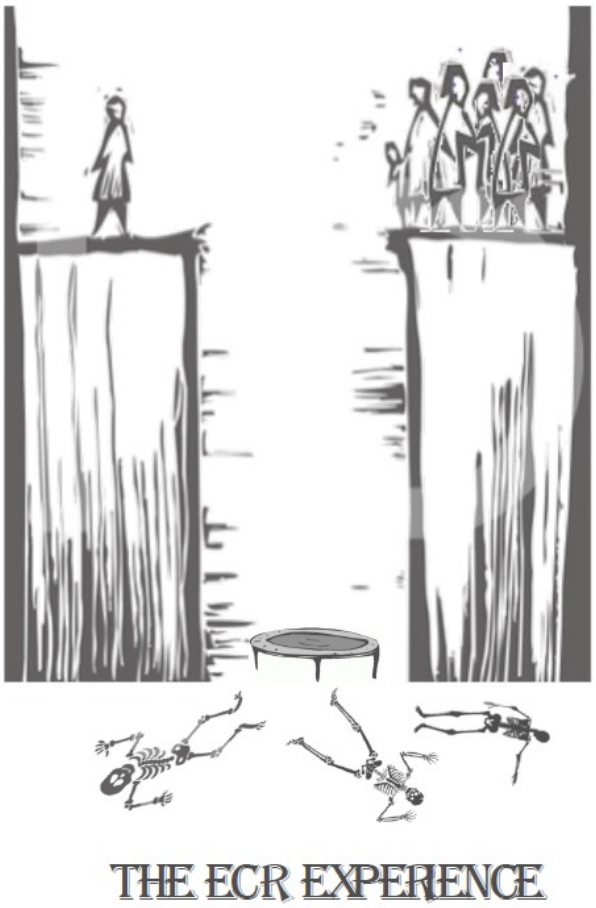


Image included with permission of Prof Don Newgreen

2.1 Introduction

The overarching purpose of this research project is to explore the challenges faced by early-career researchers in the sciences in Australia and the consequent effect of those challenges on their careers. I aimed to explore the supports and barriers in the research workplace and to identify the relationships between job satisfaction or dissatisfaction of these ECRs and their consequent effect on the likelihood of their staying in science. As a first step I will explain the scope of the literature review and the method I employed for reviewing the literature. As it was known that the situation in Australia reflects similar circumstances in many other countries (Friesenhahn & Beaudry, 2014) I began with a broad approach, identifying and exploring previous research conducted about difficulties faced by ECRs in the sciences internationally, then moved to examine the situation in Australia. In all cases I was interested to read about any steps taken to address these difficulties, where documented. A more detailed exploration of several major themes which emerged from the broader review will follow; this includes literature relating to the workplace, job satisfaction and intention to leave, job insecurity, gender inequity and women in STEMM. There is also an exploration of avenues which can be used to address some of these challenges in the STEM workplace including leadership and mentoring, professional development and alternate careers for people from STEM disciplines. Exploration of all these themes led to development of my research questions.

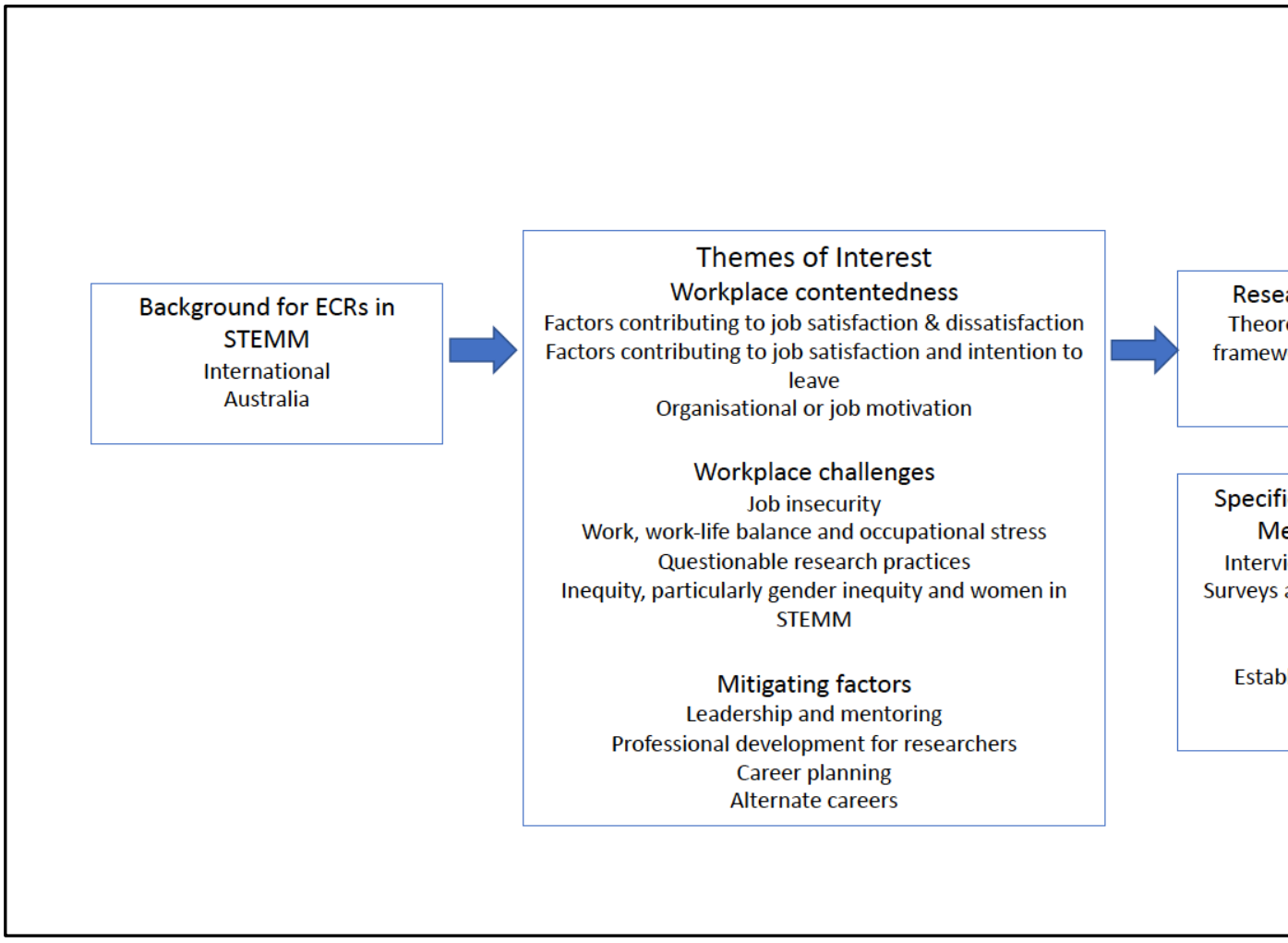
The next part of this literature review identifies and explores the many theories and methodologies which supported previous research, and which ultimately led to the selection of the mixed methods approach. It then moves to the methods utilised within this research project. The nature of this project, and the fact that it is social science research about scientists have made it very inter-disciplinary and topics covered have been very diverse.

Reviews of the literature to inform each of the three papers which contribute to this thesis are included here in Chapter 2 although of course they are also referred to within the papers.

Figure 1 illustrates the organisation of the literature review.

Figure 1

Map of Literature Review



2.1.1 Scope of the literature reviewed

I initially explored the literature pertaining to ECRs, and to scientists in general, both in Australia and internationally. Literature was sourced from a diverse range of fields including science and medicine, education and training and social science, and a range of databases including PubMed, Informit, EBSCO and Google Scholar were used to identify relevant publications. Having found a body of literature about the challenges facing ECRs, particularly internationally, I explored the literature to find information about the efforts of organisations representing ECRs, higher education bodies and professional societies to address these difficulties by following citation "trails" in relevant papers. This led to literature about job satisfaction and intention to leave the workplace and topics relating to the contentedness of the employee in the workplace.

Search terms proved difficult in the initial search, simply because the peer-reviewed target literature is not extensive. Many search terms I expected to be effective picked up no references. The most effective search terms have been "early career", "research management" and "challenges", "research personnel" and "training", "research management" and "science", "job satisfaction" and "science", "transferable skills" or "soft skills".

Common keywords from relevant articles include the terms above plus "career development", "junior faculty", "mentoring", "mentorship", "researcher development", "trainee". Keywords for more specific areas of interest have included "discrimination", "diversity", "equity", "higher education", "gender inequity" and "women".

In taking these approaches I identified a deep and lasting interest in the careers of ECRs in STEMM fields from the editors of the well-respected scientific journals Nature and Science. Although there is very little peer-reviewed literature on the topics I was seeking in

these high impact journals they find it sufficiently important to regularly feature the troubles of ECRs in special issues, commissioned pieces and editorials such as Science (vol. 285, no. 3, September 1999), or Nature's October 27, 2016 issue (vol 538), each devoted to describing the pressures experienced by young scientists, particularly as a consequence of their need to publish and to attract further funding (Benedictus & Miedna, 2016; [Editor, Nature], 2016; Gewin, 2016; Maher & Anfres, 2016; Oni, 2016; Powell, 2016a). These journals include their own opinion pieces and invited articles as well as references to and reviews of manuscripts in the peer-reviewed literature and have been very valuable sources on topics of current interest. In spite of the fact that articles relating to science careers in Science and Nature are not peer-reviewed research, but rather editorial commentary and reporting, I have considered them to be both reliable and topical as they appear in journals of great importance to those in the scientific environments. The rest of the articles in these journals are not only peer-reviewed but offer the highest impact factors in the field.

Other journals with a consistent focus on higher education and work satisfaction included: Journal of Higher Education, Research in Higher Education, Journal of Organizational Behavior Management, Studies in Higher Education, Chronicle of Higher Education, Journal of Applied Psychology, Journal of Vocational Behavior and International Journal for Academic Development, however most of their articles look at academia across all stages and all disciplines and not just ECRs or STEM environments. Journals of professional societies such as The American Journal of Surgery, Journal of the American College of Radiology were also relevant as they provide perspectives on the work environments of clinical researchers which are otherwise difficult to find.

Professional bodies representing or concerned with the education of ECRs provided useful sources of information. International organisations which have addressed concerns

about ECRs included Global Young Academy (Coussens, 2017; Friesenhahn & Beaudry, 2014; Geffers et al., 2017), National Science Federation (USA), (Phou, 2017), European Science Foundation (European Science Foundation, 2015, 2017) and Vitae (UK) (Bogle et al., 2018; Sugars, 2016; Vitae, 2011, 2012, 2013, 2019). In Australia there are organisations, both government-supported and independent, which have taken a particular interest in these topics over many years. These bodies have published their own research and reviews into difficulties faced by ECRs; some have also offered recommendations for overcoming them, however many have done so in commissioned reports rather than in peer-reviewed literature. These organisations include Australia Research Council (Bazeley et al., 1996; Bell & Yates, 2015), Association of Australian Medical Research Institutes (2017, 2018), Australian Academy of Science and its subsidiary Early Mid Career Forum (known as EMCR Forum) (Australian Academy of Science, 2019; Dunstone & Williamson, 2016; EMCR Forum, 2016a, 2016b, 2019; Hardy, 2014; Hardy et al., 2016), Australian Society for Medical Research (Access Economics, 2003, 2008; ASMR, 2015; Deloitte, 2016; Kavallaris, 2008; Meacham, 2016; Phillips & Meacham, 2015; Schofield, 2009; Schofield & Meacham, 2011), the Federation of Australian Scientific and Technological Societies (Bell, 2009), NHMRC (National Health and Medical Research Council, 2016, 2017a, 2018a, 2020), Professional Scientists Australia (McCabe et al., 2020; Walton, 2016, 2017; Walton et al., 2018), Science in Australia Gender Equity, (SAGE) (2015), Science and Technology Australia (2019) and various Australian Government departments (Bexley et al., 2011; Bradley et al., 2008; Collins & Bulbeck, 1994; Department of Industry Innovation and Science, 2018; Gascoigne, 2012; Marceau & Preston, 1996, 1997; Watt, 2015). While some of these publications appear in peer reviewed journals and others are commissioned government or organisational reports, they are consistent in their views that the situation is not satisfactory for either ECRs, for academia as a whole or for science in Australia. It is disappointing that reports describing the poor situation have been

put forward on numerous occasions over twenty-five years, yet so little appears to have been done to rectify the situation.

2.2 Background

I examined the background for ECRs internationally before focussing on the situation in Australia.

2.2.1 The International Picture

The literature indicates that ECRs across the world have long found significant difficulties caused by lack of funding and consequent job insecurity, gender inequity, work life imbalance, and poor or insufficient professional development, (Austin, 2007a; Helbing et al., 1998; National Research Council, 2005). The summary pages of the Roberts Report (Roberts, 2002), commissioned by the UK Government in 2002, provided a typical view of the unsatisfactory life of the postdoctoral researcher at that time, particularly with respect to job insecurity and lack of career structure. This report led to the establishment of Vitae and major changes in higher education in the UK. Unfortunately, other countries have not managed the same level of change and, in fact, this situation still exists, even in the UK (Bogle, 2018; Bogle et al., 2018; Karlin, 2019; Wellcome Trust, 2020). As more and more PhD students complete each year it appears their academic institutions are becoming less likely to be able to provide them with a clear and secure career path (McCarthy & Wieke, 2019; Sauermann & Roach, 2016). The biggest issue has long been and remains lack of job security as a consequence of insufficient funding (Basak & Govender, 2015; Boman, 2017; Friesenhahn & Beaudry, 2014; Helbing et al., 1998; Signoret et al., 2018). This lack of job security and funding leads to enormous pressure on the early-career scientist to publish in

order to attract further funding (Bentley et al., 2013; [Editor, Nature], 2016; Maher & Anfres, 2016; Powell, 2016b; Sutherland, 2018a).

There has been an increasing interest from professional bodies in surveying the experiences of ECRs in STEM, perhaps indicating the recognition of their difficulties, including research in the USA (Grinstein & Treister, 2018; Phou, 2017; Zusi, 2016) and in Europe where ECRs have been surveyed by organisations including European Science Foundation (2017), Wellcome Trust (2020), Young Academy of Europe (Susi, 2018), Max Planck Society (Abbott, 2020) and National Junior Faculty of Sweden (Signoret et al., 2018).

2.1.1.1 The Situation in Australia

The Australian Government strongly expresses support for developing science and scientists in Australia (Department of Industry, Innovation and Science, 2017; Department of Industry Innovation and Science, 2018). Yet, as for those working in other countries, the information available about the Australian workplace shows the difficult, uncertain environment for ECRs in STEMM is consistently related to insufficient funding and consequent lack of job security. Concerns for Australian ECRs are expressed in research conducted by bodies representing scientists including Australian Society for Medical Research (Kavallaris, 2008; Phillips & Meacham, 2015; Schofield & Meacham, 2011), Early Mid Career Forum, (Hardy, 2014; Hardy et al., 2016) and Professional Scientists Australia (McCabe & Schubert, 2020; Walton, 2016; Walton et al., 2018) and key funding bodies Australian Research Council (Bell & Yates, 2015) and NHMRC (National Health and Medical Research Council, 2016, 2017a, 2018a, 2020). While these bodies clearly have a vested interest in the well-being of their "constituents" and may be actively promoting views about problems in order to encourage change they are well-placed to hold a view about their working conditions and their future careers. The authors are researchers themselves and

appear to report a balanced view, acknowledging Australia has an internationally competitive research sector and reflecting that most ECRs want a long-term career in research, and believe they can achieve that aim, but only if they can have sustained funding and increased job security.

The focus of the research from both the Government and the professional bodies is generally on insufficient funding and its consequences for the STEMM workforce as a whole; there is limited research examining the other aspects of their academic research workplace. Exceptions include the work of Åkerlind (2005, 2008, 2009) and some later reports commissioned by various government departments (Edwards & Smith, 2008; Gascoigne, 2012; McKeon et al., 2013) and other bodies associated with higher education including the Grattan Institute (Norton, 2016; Norton et al., 2018). These works, together, investigate matters including professional development, career planning (or lack of it), mentoring and workload and find much is lacking in the current environment although none individually explores all aspects for ECRs in STEMM.

Likewise, other literature which discusses the Australian academic environment, and provides context for ECRs in STEM, tends to discuss research on academia as a whole in Australia. The body of work in this category, significant due to its extensive global coverage, is the exploration of data collected in the Changing Academic Profession (CAP) Study which was conducted over 25 countries, including Australia, in 2007 (Bentley et al., 2013; Coates et al., 2008, 2015; Coates & Goedegebuure, 2010, 2012). The Department of Education, Employment and Workplace Relations commissioned a report on the Australian academic profession (Bexley et al., 2011) and in the same year there was research on the experiences of higher education students (Edwards et al., 2011). Finally, a report from the National Tertiary Education Union (2012) ,which represents academic staff, supported the findings of the other

studies. The authors in all these publications share the view that there are systemic difficulties in the higher education sector which require urgent action.

Exploration of this background literature led me to focus my study on the factors which contribute to the STEMM research environment outside of job insecurity and lack of funding. I looked for a more in-depth investigation of literature relating to the workplace culture in academic research and to workplace challenges and means which might help address them. These are detailed below in specific themes of interest.

With respect to scope, as has been explained, I was interested in early-career researchers in the sciences in Australia. "Early-career" can be defined as within the first five years of academic employment (Bazeley, 2003; Bosanquet et al., 2017), seven years (Signoret et al., 2018) or can even be related to age (Bos et al., 2017). The EMCR Forum defines "emerging scientists" slightly more broadly, as researchers who are up to 15 years post-PhD (or other research higher degree), irrespective of their professional appointment. Global Young Academy find their early-career members are typically 30-40 years old and the typical period from completion of a PhD or similar degree is 3-10 years (Friesenhahn & Beaudry, 2014). Whichever way it is defined, the definition provides complications (Bazeley, 2003; Bosanquet et al., 2017). I chose to follow the example of Global Young Academy (Friesenhahn & Beaudry, 2014; Geffers et al., 2017), Bell (2016), Handel & Knight (2017) and National Health and Medical Research Council with respect to its "New Investigators" category (no longer applicable, since 2019 grant rounds) in defining ECRs as being up to 10 years postdoctoral.

2.3 Major Themes of Interest

The literature review included searches for papers on some specific areas of interest to the ECR experience, both internationally and in Australia. First, I explain any relevant findings which relate to general literature, then narrow it from academia in general, to the scientific environment, to ECRs in particular and, where available, the situation in Australia.

2.3.1 Workplace Contentedness

There is much previous research on the experiences of people in the workplace in general, including some about the academic workplace, however there is less about the workplace for early-career researchers and/or the scientific disciplines. I explored a number of themes with respect to the workplace experience which had consistently arisen in the background reading. These included job satisfaction and dissatisfaction, job satisfaction and intention to leave, and organisational or job motivation.

2.3.1.1 Job Satisfaction

Job satisfaction has long been shown to be directly linked to an individual's happiness, (Kornhauser, 1965), to attendance at work (Scott & Taylor, 1985), to factors including organisational commitment and citizenship (Ashford et al., 1989; Podsakoff et al., 2000), and workplace stress (Trivellas et al., 2013) and to emotional intelligence (Sony & Mekoth, 2016). Many modern organisations actively strive to enhance the satisfaction of their employees as it has been recognised that that the "happier" employees are, the better will be their attitude toward the work and higher will be their motivation, performance and commitment to their organisation (Fogaça & Coelho Junior, 2016).

Job satisfaction has been considered in literature about the academic workplace since Maslow's theory of motivation (Maslow, 1943) and his later theory of the hierarchy of needs (Maslow, 1954, 1970). Herzberg et al. (1959) built on these theories to develop a theory of job satisfaction which suggested that work-related variables which contribute to job satisfaction are different from those which contribute to job dissatisfaction. Herzberg's eventual two factor theory (Herzberg, 1964) is complicated, and argues that to not have job satisfaction does not mean there is job dissatisfaction, but only lack of job satisfaction while absence of job dissatisfaction does not mean satisfaction exists. Many job satisfaction theories have been put forward since Herzberg's theory, however Lacy & Sheehan (1997) argued that while it was recognised that though this theory is less than perfect, no better explanatory tool had emerged. Hagedorn (2000) proposed a complex framework for job satisfaction for university academics based on Herzberg's model which addressed "triggers" and "mediators" Hagedorn (2000, p7) for job satisfaction. The topic has also been addressed by August & Waltman (2004) and Blackburn & Lawrence (1995) and later by Sutherland (2018a) and by Miller & Feldman (2015) who looked more at job dissatisfaction. Basak & Govender (2015) developed another model of the job satisfaction of university academics, concluding that regardless of which theory is followed, work itself, and key factors including salary and compensation, job security, working conditions, promotional opportunities, supervision, administration and management, individual's personal characteristics, facilities, commitments and workloads appear to be important to university academics' job satisfaction.

While the literature on job satisfaction in general is considerable, there is comparatively little work on job satisfaction for people in academia aside from that mentioned above. There appears to have been no framework developed for the factors contributing to job satisfaction and intention to leave in the research environment. When the literature is narrowed down to the Australian context there is material available about satisfaction of

people employed in higher education in general, which mostly focusses on the need for change (Bentley et al., 2013; Coates et al., 2008, 2015; Coates & Goedegebuure, 2010, 2012; Lacy & Sheehan, 1997; Petersen, 2011; Reynolds et al., 2018; Sutherland, 2018b; White, 2014). Bentley et al. (2013) question the sustainability of Australian academia as a consequence of the dissatisfaction of academic staff and suggest universities should pay attention to their primary sources of satisfaction and dissatisfaction. Coates & Goedegebuure (2008, 2010, 2012) and Coates et al. (2015) look at academic work and the changing academic workforce and express concerns about the likely future and, as mentioned above, Winefield et al. (2008) show Australian academics list their long working hours and poor institutional leadership as major sources of job dissatisfaction. More recently Sutherland (2018b, p. 98) finds "it is clear that Australian academics appear to be less satisfied than many other academics around the world". The agreement between all these authors suggests job dissatisfaction is indeed commonplace in academic institutions and has been so for a long time, although there are no attempts to bring the various factors together into a framework.

Regardless of all this literature mentioned above, there is very little evidence of research into job satisfaction of those working in STEMM fields in Australia apart from the work of bodies representing scientists mentioned above in the Background. An exception is the work of Åkerlind (2005) which was part of a larger study conducted by Thompson et al. (2001) for the Department of Education and Training. Although this work looked at ECRs from all disciplines the majority of respondents (84%) were from the sciences. Thompson and Åkerlind were among the first to conduct "research on researchers" in Australia and they investigate academics' ways of understanding their research positions. Åkerlind (2005) conducted an interview-based investigation of the views of both postdoctoral researchers and postdoctoral supervisors with regard to the nature of postdoctoral research positions and the career development support provided within those positions. She found there was a

substantial variation in the functions of ECR positions and, despite a widespread perception among both ECRs and their supervisors of limited employment opportunities in academia or research positions for ECRs, there was a consistent expectation that the postdoctoral period was to provide preparation for such positions. Later work focussing on researchers in STEMM was conducted by Laudel & Gläser (2008) who interviewed a small number of ECRs from STEM disciplines. They found ECRs are forced to become independent researchers in the postdoctoral period, which usually consists of one or more short, fixed-term employments in which their autonomy and access to funding may be limited. A more recent exception is the work of Bell & Yates (2015) who examined the experiences of women in the scientific research workforce (across all levels) with both a survey and interviews and found job security was the single factor which most increases job satisfaction, and that other factors including professional contexts such as discipline and employment status held further influence. In another very important study for the time, White (2014) discussed the job satisfaction of women and early-career academics in STEMM fields, though her research involved interviewing a limited sample (of 40 women) drawn from only one institution as well as analysis of statistics relating to gender imbalance within that institution.

While these studies have all been valuable, as they have contributed to understanding the academic workplace for scientists, it is many years since most were conducted and up to date and more wide-ranging data is required. There is an opportunity to extend the survey and interview work of those described above to provide a broader and updated reach into the environment for all ECRs in all STEMM fields. It appears there has been little change in the workplace situation since this data was collected except where it has possibly become worse, as reported in recent Government reports and journalistic pieces (ABC, 2019; National Health and Medical Research Council, 2019; Nogrady, 2019; Shine et al., 2019; Walker, 2018). If the

views in these publications remain reflective of the current situation, then it is important to collect further data in order to push for change on the basis of current data.

2.3.1.2 Use of Structural Equation Modelling to Define Factors Relating to Job Satisfaction

In order to identify any modelling of factors relating satisfaction in academia, I conducted a systematic review of the literature for articles on the use of structural equation modelling (SEM) to identify factors contributing to job satisfaction. I searched for articles published since Johnsrud & Rosser (2002) (see reference to this paper in Section 2.3.1.3) and up to January 2020 (the time of the search) where SEM was used to investigate job satisfaction and any factors relating to it in academia. The method used for this search, and its outcome, are described in detail in Chapter 3 (Section 3.9.1.2).

In conducting this systematic review, I identified 10 papers for which the authors had used SEM to explore job satisfaction and related factors in the academic environment (see (Section 3.9.1.2.1). There appeared to be no research which describes conceptual models of factors contributing to job satisfaction for people employed in the scientific environment, or the research environment, in universities or research institutes and which could be applied to quantitative data.

2.3.1.3 Job Satisfaction and Intention to leave

Intention of ECRs in the sciences to leave academic research was also of interest so I investigated relevant literature. Johnsrud and Rosser (2002) proposed a model based on Herzberg's model to ascertain the impact of faculty worklife and morale on intent to leave and determine whether the impact is a function of individual or institutional perceptions. In subsequent work Rosser (2004) found that faculty members perceptions of their worklife have

a direct and powerful impact on their satisfaction, and subsequently their intentions to leave. Intention to leave appears to be a predictor of actually leaving (Lee & Mowday, 1987). Schuster & Finkelstein (2008) showed job satisfaction levels were reflected in the decision to change jobs and were particularly influenced by supportive culture. Earlier, Manger & Eikeland (1990) had found relationships with colleagues had great significance for job satisfaction and intention to leave in a university setting, data confirmed by Lacy & Sheehan (1997) who showed university atmosphere was another factor which had an impact on job satisfaction and intention to leave the institution. This supports the work of Dick et al. (2004) (looking at management in general, not just academia) who, using a framework of social identity, proposed that strong organisational identification is associated with low turnover intentions, and the relationship between organisational identification and turnover is mediated by job satisfaction.

In closer alignment to this proposed study, three North American studies have investigated the links between job satisfaction and intention to leave in academics in STEM disciplines. In the first, Bozeman & Gaughan (2011) sought to understand job satisfaction of academic faculty, focusing on three different sets of variables—characteristics of the individual, the work context and institutional interactions. They evaluated the effects of gender, race, marriage, and field at the individual level; and looked at factors including tenure, work composition, interactions with colleagues, and views about salary at the job level; and research centre affiliation and industry collaboration at the institutional level. Bozeman & Gaughan (2011) found the strongest predictor of job satisfaction is for the respondent's research to be recognised by departmental colleagues.

In a second study, Miller & Feldman (2015) noted there has been little empirical investigation of the individual postdoc experience and the factors that influence dissatisfaction

with postdoc appointments, even though addressing these concerns is important to the overall scientific environment, as well as having implications for the careers of individuals. Miller and Feldman's analysis of data from a large survey conducted in 2010 showed dissatisfaction with the ECR experience contributes to the decisions of many scientists to change their career, thus not realising the full returns to either their personal or the societal investment. Miller and Feldman (2015) believe scientists are motivated by an intrinsic interest in extending the boundaries of knowledge. They also hypothesise the quality of structured oversight provided is a factor which contributes to job satisfaction and showed having advisors providing effective mentoring and oversight were associated with a lower probability of dissatisfaction. They found ECRs in high quality programs appeared to appreciate the increased freedom to shape their own research projects, but this was offset by less access to advisors, resulting in no net gain from program quality. This finding is consistent with earlier work which showed the dependence of job satisfaction on both autonomy and feedback, especially for workers concerned about career growth (Loher et al., 1985).

In the third and most recent study, conducted in 2015, Grinstein & Treister (2018) conducted a survey of ECRs mostly in the biomedical and physical sciences in order to measure satisfaction of ECRs and how likely they were to change their career goals of (typically) obtaining a tenure track appointment. They found that among a large number of factors that can enhance "life satisfaction" for ECRs only one factor stood out as significant: the degree to which atmosphere in the lab is pleasant and collegial. They found that ECRs demonstrate a surprisingly low well-being and their growing realisation that secure positions are more scarce than ever before, as well as the long, frustrating, and not always rewarding ECR journey, significantly damages their well-being and satisfaction.

Further research of interest for ECRs in STEM has been conducted in Germany by Dorenkamp & Weiß (2018) who looked at the relationship of stress and intention to leave and by Liang et al. (2019) who investigated the reasons behind Australasian women leaving surgical training. Dorenkamp & Weiß combined the four variables of work stress, psychological distress, job satisfaction, and intention to leave academia in a single structural approach, ultimately demonstrating an indirect relationship between work stress and individuals' intention to leave the profession. They noted this result is remarkable considering the relatively high levels of respondents' job satisfaction and that there was a greater impact on women ECRs than on men. In a qualitative approach, Liang et al. interviewed 12 women who had chosen to leave surgical training. They, too, found evidence of the paradoxical situation of ECRs who demonstrated job satisfaction but intention to leave, and identified six factors which contributed to the decision to go: inaccessibility of leave, a distinction between valid and invalid reasons for leave, poor mental health, absence of interactions with other women in the surgery section and other supports, fear of repercussion, and insufficient pathways for independent and specific support. In a very interesting conclusion, they hypothesise women might be better assisted to stay by interventions that do not focus unduly on gender. Instead, they suggest interventions are likely to improve surgical training for both women and men because many factors, such as long working hours and unpredictable lifestyle affect all trainees. There is also a sense of equality in the idea that work done to advance the cause of women in surgery should not do so at the expense of men.

Some other factors identified in the literature as contributing to satisfaction and dissatisfaction and intention to leave are identified in Table 1 below. While the importance of some of these factors for researchers elsewhere are covered thoroughly in the literature, there is limited research for Australia and very little information has been gathered for ECRs in STEMM fields. It was expected that similar research in Australia would be likely to confirm

the findings of these five studies and we proposed to explore the links between the factors these authors suggested as well as other factors known or expected to influence job satisfaction and intention to leave.

Table 1

Factors Contributing to Job Satisfaction or Dissatisfaction in Addition to those Described in 2.3.1.3

Factors Causing Concern	Sub-factors			References
Lack of work-life balance	Conflict with family responsibilities	Lack of research time		(Bentley et al., 2013; Johnsrud & Rosser, 2002)
Stress				(Bentley et al., 2013; Johnsrud & Rosser, 2002)
Resources for research	Difficulty in obtaining travel funds to present research or visit collaborators	Competition for limited resources, lack of administrative support	Lack of funds for equipment or consumables	(Bentley et al., 2013; Johnsrud & Rosser, 2002; Petsko et al., 2014)
Bullying and harassment				(Else, 2018; Liang et al., 2019)
Supervision and organisational leadership	Lack of interest of superiors/poor leadership	Poor access to superiors	Lack of mentoring or of role models	(Ashbaugh, 2003; Liang et al., 2019; Petsko et al., 2014)
Unmanageable workloads	Lack of administrative Support	increasing accountability requirements		(Dorenkamp & Weiß, 2018; Liang et al., 2019)
Career planning	Lack of advice	Lack of further opportunity		(Bentley et al., 2013; Petsko et al., 2014)
Caring responsibilities	Parental leave and child caring	Caring responsibilities for other family members		(Bentley et al., 2013; Liang et al., 2019)
Training	Lack of Training Opportunities	Poor supervision		(Ashbaugh, 2003; Liang et al., 2019; Lopes et al., 2017)
Gender inequity	Lack of role models	Inappropriate hiring	Imbalance in publishing, funding, representation on panels	(Levine et al., 2011; Liang et al., 2019; Rickard et al., 2018; Rosser & Tabata, 2010)
Salary				(Bentley et al., 2013; Johnsrud & Rosser, 2002)

2.3.1.4 Organisational or Job Motivation

General workplace literature (for example, Corporate Leadership Council, 2004; Herzberg et al., 1959; Meyer & Maltin, 2010) establishes that in order to increase efficiency, effectiveness, productivity and job commitment of employees, a business must satisfy the needs of its employees by providing good working conditions. It is essential for an organisation to motivate its employees to work hard for achieving the organisational goals and objectives (Raziq, 2015) and job satisfaction is an important factor in this motivation. A research institution, however, tends to be an unusual workplace. While it is certainly desirable for research institutions to provide good working conditions (something which appears to not necessarily be the case in practice (Wellcome Trust, 2020) there are ways in which a research institution might be different from other workplaces. Where in a more usual workplace such as a company in industry, there are common goal or goals, I have observed a research institution is likely to be made up of a large number of small groups (often referred to as laboratories) which, while perhaps pursuing the same overarching goal of common good, say, a cure for diabetes, will all actually have individual and possibly disparate goals. Research institutes and universities act as the employer, but in reality, these autonomous small groups must compete with one another for limited funding, and the scientists are often simply left to manage their own teams (Smith, 2020). The success of one lab is not dependent on that of another, so this literature about motivation in the general workplace, while valid, is not applicable to those working in the scientific research setting other than with respect to the goals common to all the researchers of publishing and attracting funding.

There is limited literature on the motivation of academics, other than on their motivation to teach, and very little on the motivation of academics in STEM fields (Lechuga, 2012). Somewhat related to motivation is the passion researchers appear to have for their

work in spite of the obstacles they face, and which cause them considerable stress. This paradoxical situation is discussed by some (Bexley et al., 2011; Gascoigne, 2012). This research project has aimed to contribute to filling gaps in this limited literature about motivation and satisfaction for those working in academic STEM disciplines.

2.3.2 Workplace Challenges

As described in the Background, ECRs encounter many challenges in their workplace. I have specifically investigated literature about job insecurity and its impact, work-life balance and workplace stress, questionable research practices and inequity, particularly gender inequity. These topics were selected as they emerged from the literature as the overwhelming factors detracting from job satisfaction in the STEM workplace today and are addressed in more detail below.

2.3.2.1 Job Insecurity

There is extensive evidence in the literature, as explained above, indicating that insufficient funding is the first and overwhelming problem for ECRs, internationally and in Australia. The pressure to publish is the second, related problem which has been clearly demonstrated to dominate the research environment (Benedictus & Miedna, 2016; [Editor, Nature], 2016; Gewin, 2016; Maher & Anfres, 2016; Oni, 2016; Powell, 2016b). As mentioned above, it is imperative to publish in order to develop a track record and thus have the potential to attract funding and retain a job. An editorial in a special 2016 edition of Nature said "Young scientists today face a harsher, more competitive, stricter, more dispiriting workplace than their bosses and senior colleagues did at the same stages of their own careers. Things are simply not the same as they were back in the day. They are more difficult." ([Editor, Nature], 2016, p.427).

Both reports commissioned by the Government and research conducted by bodies representing scientists indicate Australia may be losing many able young scientists to a career in science because the stress of the environment and the lack of permanent positions is simply not worth it (Bell, 2016; EMCR Forum, 2017; Gascoigne, 2012; Kavallaris, 2008; Meacham, 2016). Lacy & Sheehan (1997) examined job insecurity in academics in Australia and found 58% were satisfied with their security (54% in science faculties) but ASMR's 2016 survey showed the situation had worsened as 75% of respondents said that a lack of job security had negatively impacted their career (Meacham, 2016). There is previous research on the contribution to stress from factors including job insecurity and job dissatisfaction discussed below.

2.3.2.3 Work, Work-life Balance and Occupational Stress

Topics of interest which were incorporated into this project included relationships between work and occupational stress (Iacovides et al., 2003; Kinman & Wray, 2020) and work and well-being (Bakker & Demerouti, 2007; Kinman & Wray, 2014). It has been shown that job characteristics can have a profound impact on employee wellbeing (e.g. through job strain, burnout, work engagement) as demonstrated in the Job Demand-Resources Model developed by Bakker & Demerout (2007). Well-being, mentioned above as a contributor to job satisfaction and intention to leave, has been demonstrated to have an impact on organisational performance (Daniels & Harris, 2000; Robbins & Judge, 2012) and on organisational commitment (Liao et al., 2009; Lok & Crawford, 2004; McDonald & Makin, 2000).

Academics, including Australian academics, are known to work long hours (Misra et al., 2012; O'Laughlin & Bischoff, 2005) and there is a corresponding likelihood of work-life conflict and occupational stress (Gascoigne, 2012; Kinman, 2014; Winefield et al., 2008).

There are studies which examine work-life conflict, particularly those that look at the Rational Model of Work-life Conflict (Hogan et al., 2015; O'Laughlin & Bischoff, 2005) which suggest the greater the number of hours spent at work, the greater the potential for work-life conflict. A recent series of interviews with researchers which appeared in Nature called for a change to the workplace culture and a "kinder kind of science" (Powell, 2018).

2.3.2.4 Questionable Research Practices

It is possible the job insecurity and the urgency to attract funding which so colour the STEM workplace experience lead to questionable research practices (Begley & Ellis, 2012; Stürmer et al., 2017; Wellcome Trust, 2020). A search of the current literature found that little is written about these practices in Australia or about their impact on Australian researchers. Some exceptions include an article which calls for an Australian Office of Research Integrity (Vaux, 2013) , another by Doran (2016) and, more recently, a warning from Australia's Chief Scientist that research fraud might be a problem in our stressful research environment (Finkel, 2019). The known questionable research practices elsewhere together with the lack of literature about the situation Australia indicate the need for further study of our local environment.

2.3.2.5 Inequity

The international literature provides evidence of inequity in academic STEM workplaces, be it racial, age related, gender-related or some other form ([Editor, Nature], 2018a; Funk & Parker, 2018; Sohn, 2018a, 2018b; Turner & Myers, 2000). Our study has sought to further explore inequity in the academic STEMM workplace in Australia as it appears there is little work on inequity to date, other than on gender inequity.

2.2.2.6 Gender Inequity and Women in STEMM

While all inequity is troubling, there can be no doubt that gender inequity for women is a hot topic and particularly so for women in STEMM. Gender inequity in science has been addressed for many years (Ley & Hamilton, 2008; Mayer & Tikka, 2008; Moss-Racusin et al., 2012) and remains a matter of concern for scientists all over the world (Gewin, 2017b, 2017a; LERU, 2018; Moss-Racusin et al., 2012; Sugimoto et al., 2014; Woolston, 2018a). The literature on gender inequity in general (of which there is a significant amount) (see Christian (2018b) for multiple links) points out discrimination with respect to hiring procedures, grant-allocating processes and publishing.

In Australia, there has also been work on gender inequity in academia over decades (Asmar, 1999; S. Bell & Yates, 2015; Carrington & Pratt, 2003; Chesterman et al., 2005; Diezmann & Grieshaber, 2010a, 2010b; Quinlan, 1999; Diezmann & Grieshaber, 2013; White, 2001, 2004, 2014; Winchester & Browning, 2015); more recent work includes Holman et al. (2018); Nash & Moore (2018); Rickard et al. (2018); Shine et al. (2019) and White & Burkinshaw (2019). Of great concern to many of these authors is the consistent decline, with seniority, in the levels of female representation amongst academic staff (Bell & Yates, 2015; National Health and Medical Research Council, 2017b, 2019).

The Australian Government is making serious efforts to support and encourage the inclusion of women in science. Martinez et al. (2007) identified the postdoc period as a juncture where many women in the USA exit or reduce their commitment to the scientific workforce and it appears likely that this is still the case in Australia (Bartone et al., 2019; Liang et al., 2019). The Australian Research Council now includes a section on gender in its biennial ERA Report on the State of Australian University Research (Australia Research Council, 2019) and the NHMRC has published evidence of its concerns (National Health and

Medical Research Council, 2017b, 2019; Nogrady, 2019). The Australian Academy of Science established Science in Australia Gender Equity (SAGE) as a national program promoting gender equity and gender diversity in STEMM, as an Australian pilot of the highly successful Athena SWAN charter established in the UK (Ovseiko et al., 2017; Science in Australia Gender Equity, 2015, 2018).

2.3.3 Mitigating Factors

There are certainly steps which can be, and sometimes are, taken to address some of the challenges in the STEM workplace. These include good leadership and mentoring and professional development, including skills development and training and career planning. Last, there are opportunities (though sometimes unrecognised) for these ECRs to move out of the academic research environment to establish successful alternative careers.

2.3.3.1 Leadership and mentoring

I also explored the literature about leadership and leadership training, given that institutional leadership is key to the environment for those in the care of leaders. There are clearly leadership problems in many scientific workplaces as has been reported regularly in Nature (Leiserson & McVinney, 2015; Van Noorden, 2018; Woolston, 2019), but there is little in the literature about actually addressing the problems of poor leadership or, indeed about their cause.

Mentoring is a key element of professional development which has been shown to be of great benefit to ECRs (Gonzalez et al., 2019). Ogdie et al. (2017), for example, examined facilitators and barriers to a successful career in the clinical environment and found mentoring is critical to the development and sustenance of a career in rheumatology research. At the same time, it appears mentoring is not available for all (Gonzalez et al., 2019; Lashuel, 2020).

There is interest in reading about mentoring: "Nature's Guide to Mentors" (Lee, 2007) led to the establishment of an annual mentoring feature in Nature; Lee's mentoring website Guidelines on Research Mentoring which was set up after this article was published in 2007 addresses the role of the supervisor and organisational leadership rather than that of an independent mentor for advice and has had over 220,000 reads (Lee, personal communication, 2020).

It was difficult to understand why mentoring is not more readily available when there is so much advice about how to go about it (Bavel et al., 2019; Vance et al., 2017; Woolston, 2019) and more about its benefits, (Liénard et al., 2018; Prinz, 2016) so this, too, was added to the list of matters to explore in the STEM environment.

There was no significant literature available about leadership and mentoring for scientists in academic research in Australia; I drew the conclusion that more information on both needs to be collected and reported.

2.3.3.2 Professional Development

Research into researchers is a relatively new field (Browning et al., 2014) however the issues facing ECRs across academia have been a focus of increasing concern since early in the twenty-first century (Roberts, 2002). Since then efforts have been made to improve the workplace environment for ECRs at large (Gonzalez et al., 2019; Mellors-Bourne & Metcalf, 2017; Vitae, 2011). The efforts of Vitae with the development of the Concordat for Researcher Development (Bogle et al., 2018; Mellors-Bourne & Metcalf, 2017; Vitae, 2019) and the efforts of the National Academies of Science (National Academies of Sciences, 2018; National Research Council, 2005) in the USA have made very significant contributions to those in the UK and USA.

There is some research focussed particularly on people working in scientific environments by organisations developed to look after their welfare including the Global Young Academy, European Science Foundation and the Max Planck Institutes (European Science Foundation, 2015, 2017; Friesenhahn & Beaudry, 2014; Jahn, 2018). All these organisations have canvassed large numbers of their stakeholders across the world with well-constructed research projects, providing clear outcomes and recommendations. A great deal of work on professional development for researchers has also been done outside of Australia by funding bodies including National Institute of Health in USA and Wellcome Trust in the UK (Gilliland et al., 2017; Karlin, 2019; Ognibene et al., 2016). The introduction of professional development programs teaching generic skills, numerous ways to address gender and racial inequity, introduction of mentoring schemes and a change in ways to evaluate success are some examples of the implementation of these programs reported by Vitae in their analysis of the successes and positive impact of the Concordat for Researcher Development (Mellors-Bourne & Metcalf, 2017). Exploration of the literature about the benefits of professional development shows that investing in ECRs' professional development may help them towards long-term success and thus keep them in science (Bogle et al., 2018; Christian, 2018a; Department of Industry Innovation and Science, 2018; Robbins & LePeau, 2018). As this professional development has been shown to be so beneficial for ECRs elsewhere, it was expected investigation of the opportunities available to ECRs in Australia and the views of the ECRs to those opportunities would be a worthwhile component to the proposed research.

When examining researcher development, previous researchers have focussed more often on the doctoral environment than on the workplace environment for early-career researcher, and have typically done so in reports commissioned by Government departments with a focus on higher education strategy (such as NBEET, 2012) or the demands for the workforces of the future (Edwards & Smith, 2008). The situation regarding professional

development (or lack of it) is summed up in a follow-up article in Science (Austin, 2007b) which discussed the results of a survey following a feature on "Lab Management in Science" which asked people whether they had received lab-management training. This Science poll found only 4% of all scientists had received formal management training and fewer than half have received any management training at all, yet these people have responsibility for personnel, equipment and significant budgets. Austin urged readers to ponder about the consequences of such lack of training. Eleven years later, an editorial in Nature ([Editor, Nature], 2016) provided a comprehensive summary of the situation for ECRs, stressing that funders and institutions should make fewer demands on ECRs, and provide more support. Again, this editorial shows ECRs have generally not yet learnt – or been taught - the complementary professional skills such as budgeting, grant-writing and managing staff which are critical to success (Bogle et al., 2018; Christian, 2018a; Department of Industry Innovation and Science, 2018; Robbins & LePeau, 2018). At the same time, the Nature summary ([Editor, Nature], 2016) concludes ECRs who are struggling with this lack of training are less likely than their more senior colleagues to have support staff, a situation I believe is likely to be replicated in Australia. ECRs are typically also struggling with balancing work and home life as they are more likely than their seniors to have young children and they may well have spouses with their own professional obligations, often in the sciences too. It is typical that these young researchers must address their most urgent needs - to secure the funding and publications without which they cannot have a job (Hardy et al., 2016; Powell, 2018) - by sacrificing activities which will assist them in the long term, such as learning how to run a lab smoothly (Austin, 2007a; Christian, 2018a).

Following the clear evidence from overseas that it is beneficial to invest in researcher development, there is now some Australasian research pointing out the benefits to the ECRs of professional development and encouragement of its routine inclusion for the postdoctoral

years as Browning et al. (2016, 2017) have explored researcher development across academia recently in Australia, and Sutherland (2018b, 2018d) has done so in New Zealand. There is little literature about research into supports and barriers for early-career researchers in STEMM outside funding and job insecurity, other than that conducted by Åkerlind (2009), although the EMCR Forum has recently indicated interest in professional development needs of ECRs in STEM in Australia. EMCR Forum conducted a survey about this in 2019 and subsequently instituted a pilot professional development program (Australian Academy of Science, 2019); although information about this has not yet been published, I assume this step has been taken in order to address a gap the members of EMCR Forum have identified in this area.

Within the broader field of professional development, some researchers have discussed the need for training in "generic management skills" and find these skills just as important for broad professional development in the research workplace as elsewhere (Edwards et al., 2011; Gascoigne, 2012; Manathunga et al., 2007; Robbins & LePeau, 2018; Wisker et al., 2019). Manathunga et al. (2007), looking at the training needs of higher degree research students, report many in the field argue that traditional PhD programs are too narrow, lacking broad professional development opportunities and producing overly specialized graduates. Manathunga et al. (2007) suggest addressing a range of skills including problem solving, communication, project management, understanding and applying multiple disciplinary and international perspectives, high-quality research practices, and social, ethical and environmental responsibility; this was later supported by a review of the Australian research training system (McGagh et al., 2016). My own professional experience in the sciences has led me to the same conclusions and to my publication of a text book written to address this range of skills which is often missing for young scientists (Christian, 2018a).

2.3.3.3 Career Planning

The literature shows the value of career planning for those working in higher education is becoming recognised internationally as evidenced by the work of Vitae (Bogle et al., 2018; Mellors-Bourne & Metcalf, 2017; Sutherland, 2018c, 2018d, 2018e) and in STEM disciplines by Max Planck Institutes (Jahn, 2018), the National Institute of Health, USA (Gilliland et al., 2017). There is little evidence of prior research into the approach to career planning taken by ECRs in STEM, in spite of the uncertain nature of a research career (Signoret et al., 2018). Looking broadly at research careers in Australia, Amundsen et al. (2013) reflected we know little of the ways in which individuals perceive and navigate the transition from PhD to new careers. Some recommend that ECRs need to determine what steps need to be completed for their next career move and that organisations need to provide opportunities for skill development with appropriate internal training to facilitate these career plans (Christian, 2018a; Dudovskiy, 2014; Hardy, 2014).

The limited availability of literature on career planning for ECRs in STEMM disciplines in Australia has provided yet another avenue to explore in this research project.

2.3.3.4 Alternate Careers

The strongly preferred career path for ECRs in STEMM is in academia; it seems alternate careers are considered reluctantly and are often regarded as being for failed researchers (Åkerlind, 2005; Payne, 2019). There is little research on the perceptions of alternate careers to the ECRs in academic research in Australia although there has some discussion on the values of "starting the conversation" (EMCR Forum, 2016a) and some discussion of the views of potential employers of STEM postdocs who question their value (Edwards & Smith, 2008). Making such a transition would not sit comfortably for many with

their identity as a scientist and researcher, a view supported by Bell and Yates (2015) and Gascoigne (2012) and further tested in my research.

Edwards et al. (2011) recommended further support should be provided to students during their degree to prepare them for work outside the university sector and/or for the academic tasks of teaching, research and administration and point out the importance of simultaneously ensuring a balance between the alignment of the research degree with the realistic career ambitions of students. These recommendations align with those of another Australian Government Report (NBEET, 2012) and the advice of Payne (2019), both of which recommend universities should prepare their students by offering career advice and internship experience in industry. Whether in academia, industry, non-profits or government, there are many places to do science, and many ways to be a scientist though ECRs seem to be reluctant to consider them (McGagh et al., 2016; Woolston, 2018b).

As reported above, training except that directly related to the scientific discipline is reported to be lacking, so, without generic management skills, and without good information about alternate careers ECRs tend to find themselves poorly equipped for moving out of academia into industry or to other scientific careers (Austin, 2007b; Christian, 2018a; Manathunga et al., 2007, 2009).

This lack of information in the literature about the views of ECRs with regard to alternate careers and the way they could find out about them, and indeed be exposed to them, identified yet another gap to be explored in this project.

2.4 Conclusion about the ECR experience

The reading described above indicated numerous gaps in the literature which could add to the understanding of the experiences of ECRs working in the sciences in Australia,

including understanding many additional factors outside funding and job insecurity which contribute to ECRs' job satisfaction and intention to leave. I thus reviewed the literature again with a view to deciding how best to collect and then analyse the data about challenges faced by early-career researchers in the sciences in Australia which could inform these gaps and answer my research questions "What are the relationships between ECR job satisfaction or dissatisfaction and their likelihood of staying in science?" and its sub-questions:

- What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?
- What are the motivations for ECRs leaving the sciences?
- What are the specific features of the experiences and environment of those ECRs who remain in the sciences?

The next section of the literature review discusses the subsequent review of research methodology which ultimately led to the decision to conduct a mixed methods project.

2.5 Research Methodology

As a first step in examining the literature about research methodology I returned to the previous research in my fields of interest to review the conceptual and theoretical frameworks, and methods used, so I could design my research project appropriately. I then set about learning more about those methodologies.

Grove & Overton (2013) provided background for and guidance to conducting pedagogic research within the STEM disciplines. Once I had decided upon the general research question, it became clear that it was preferable to include both qualitative and quantitative research methods. Some previous projects which had resonated with my interests relied only on survey data (Australian Society of Medical Research, 2016; Hardy, 2014;

Ogdie et al., 2017); others, including Åkerlind (2005) and McAlpine & Emmioğlu (2015) collected their data from interviews. Projects which had used a variety of methods had greatly enriched their quantitative survey data with qualitative data collected in interviews, although some studies, though valuable, involved only a small number of respondents or only a single institution (Gardner, 2012; Gonzalez et al., 2019).

Ultimately, I decided to follow the "mixed methods research" path and conduct this project with a broad-scale national on-line survey enriched by qualitative data. This followed the example of researchers who had investigated people in scientific research positions (Åkerlind, 2009; Bell & Yates, 2015; Friesenhahn & Beaudry, 2014; Phou, 2017) and others who had conducted research on job satisfaction in academia in both Australia (Bentley, 2013) and New Zealand (Sutherland, 2018b) and had taken a similar approach.

Mixed methods research has been defined in many ways (Johnson et al., 2007), however the definition Johnson attributes to John Creswell is perhaps easiest to understand: "Mixed methods research is a research design (or methodology) in which the researcher collects, analyzes, and mixes (integrates or connects) both quantitative and qualitative data in a single study or a multiphase program of inquiry" (Johnson et al., 2007, p.119). Creswell (2015) simplified this definition further in later years defining the "mixed methods approach" as comprising collection and interpretation of both qualitative and quantitative data. Johnson also includes the definition used by Pat Bazeley, another leader in the field, who describes mixed methods research as involving "the use of more than one approach to or method of design, data collection or data analysis within a single program of study, with integration of the different approaches or methods occurring during the program of study, and not just at its concluding point." (Johnson et al., 2007, p.119).

Howes (2017) notes methodologists have urged researchers who use mixed methods to justify their methodological choices, provide greater clarity about the philosophical underpinnings and implications of their approaches and to share their thinking processes as they engage in research. In her own work Howes (2017) has used Greene's domains of methodology for social inquiry as a framework for addressing reflexive questions about assumptions (Greene, 2008).

The literature described above helped explain how to employ mixed methods methodology in order to bring together the benefits of both qualitative and quantitative research for this research project. In Grove and Overton's chapter on quantitative research, for example, Brown & Edmunds (2013) point out including qualitative methods will often reveal insights and new perspectives into the topics which quantitative methods cannot reach. They provide guidance on transparency, triangulation, reflectivity and respondent validation an well as guidance on conducting interviews and focus groups, topics also covered by others (Creswell, 2015; Denzin, 2012; Denzin & Lincoln (Eds), 1994; Given, 2018; Grbich, 2013). Guidance on analysis of qualitative data was provided by Creswell (2015), Flick (2009), Grbich (2013) and Silverman (2011, and in courses provided by NVivo and by Australian Consortium for Social and Political Research (ACSPRI) (Grbich, 2018).

The detailed review of methodological approaches described above resulted in my decision to design a mixed methods project which would collect quantitative data from an on-line survey (and pilot on-line survey) to be augmented by qualitative data from a focus group, open-ended questions within the on-line survey, semi-structured interviews and reflective journals. Literature about these specific methods is discussed below.

2.5.1 Specific Methods within Mixed Methods Research

2.5.1.1 Interviews and Focus Groups

Qualitative interviews are frequently used in social sciences research (Grbich, 2018; Tracy, 2019). They are often perceived as an unproblematic method (Jelen, 2018) that uncovers psychological or social realities and simply extract the information, however there are many traps for the unwary. I thus sought to understand the scholarly traditions and paradigms, methodological underpinnings, and ethical considerations surrounding interview research, as well as appropriate sampling and framing questions and then the practical data generation and management processes, involved in interviews. Various sources provided helpful information for interviewing including sound advice about the need to consider the factors which can influence interviews (personal characteristics, culture, gender, power) and which have a potential to influence the type of information revealed and knowledge communicated (Denzin & Lincoln, 2005; Grbich, 2013). Creswell (2013, 2015) and Tracy (2019) particularly address the technique of interviewing as part of mixed methods research projects and provided advice about collecting data to complement data sourced from the other methods. Barnacle (2005) discusses the technique of interpreting interview transcripts and careful coding. It was useful to be reminded about the risks and limitations of interview research as well to consider the validity, reliability and generalisability of the data collected. As well, reading this variety of texts allowed me to better understand some of the differences between the qualitative and quantitative traditions.

It was useful to read papers which offer examples of higher education research incorporating interviews (including Nash & Moore, 2018; Skakni & McAlpine, 2017; Thomas et al., 2019) to see the topics they had explored and the ways in which they grouped them. As I was particularly interested in the problems of young women in STEM in the

academic environment I sought out papers specifically focused on this type of research (including Bell & Yates, 2015; Gardner, 2012; Liang et al., 2019) and examined ways they had investigated the topics discovered during my background research. Bell and Yates (2015) conducted a series of 11 small focus groups, each made up of people from a different balance of age, seniority, working location and gender to support their survey research; Gardner (2012) employed semi-structured telephone interviews to support her survey results and Liang et al. (2019) employed interviews only, the majority of which were by phone; this paper does not specify the nature of the interviews. All these papers discuss the success in obtaining valuable data from these methods and the consequent thematic analysis.

Having chosen to interview people who had recently left academic research for a range of other work environments I consulted references about alternate careers for STEM graduates (Rochen Renner, n.d.; Shmatko et al., 2020; Woolston, 2018b; Zaringhalam, 2016) to ensure I had validly covered the most likely alternate career paths available to people in STEMM and thus had suitable sampling. I was also aware of achieving saturation from answers from the respondents (Grove & Overton, 2013).

2.5.1.2 Surveys

Just as it was necessary to understand the scholarly traditions for interviews, the same requirement was applicable to survey research. I consulted texts which discussed the theories pertaining to successful survey design and distribution (Boynton & Greenhalgh, 2004; Eysenbach, 2004) as well as references addressing non-response bias (Rogelberg & Stanton, 2007; Sax et al., 2003; Tourangeau, 2013). As I was keen to employ questions for the on-line survey from previously validated research (Boynton & Greenhalgh, 2004), I investigated literature describing surveys of academics in general, and academics working in STEMM fields in particular, conducted across the world. Internationally, Nature conducts an annual,

large scale survey of PhD students in the sciences across the world to canvas information about PhD students' career intentions and programs (Woolston, 2015, 2017) and a biennial survey of salary and job satisfaction in the global science community ([Editor, Nature], 2018b; Woolston, 2016, 2018b, 2018c). The Global Young Academy (GYA) surveyed its membership with a range of questions in 2013 (Friesenhahn & Beaudry, 2014b) and then applied updated questions to its membership in ASEAN countries in 2015 (Geffers, 2017). The results of a follow up survey in African countries (Coussens, 2017) are yet to be published. Table 2 provides information about some of the surveys described here. Invitations to participate in these surveys were generally sent to the on-line survey respondents via their institutions; ASMR and EMCR canvassed their membership group and Nature their readership. In all cases participants self-selected.

Ultimately I elected to use questions drawn from the international Nature and GYA surveys and from the National Science Foundation (USA) survey of science ECRs (Phou, 2017) as they were conducted by reputable organisations with a known though independent interest in the welfare of the respondents. I also drew questions from the Australian studies conducted by (Bell & Yates, 2015; Coates & Goedegebuure, 2007; Hardy et al., 2016) as they too were reputable and provided opportunities to make locally relevant comparisons.

This reading described above led to the selection of questions from previous studies of STEM researchers as a first preference, although none of these examined all areas of the research experience which was of interest to me, so I looked further afield. In the United Kingdom, the aggregate results from Vitae's Careers in Research Online (CROS), Principal Investigators and Research Leaders (PIRLS) surveys (Mellors-Bourne & Metcalf, 2017) and Higher Education Academy's Postgraduate Research Experience Survey (Slight, 2017) provided another good source of questions as they have been used to collect representative

views across the UK Higher Education sector about the attitudes and activities of research staff and research leaders, including ECRs. These surveys provide robust and illuminating insights into the research environment in relation to the employment and professional and career development of researchers, and the sector's progress in achieving the ambitions laid out in the UK agreement between the funders and employers of researchers in the UK (Vitae, 2008).

The Australian Academic Profession Survey (Coates et al., 2008) was an important survey of Australian academics from all fields. More specifically comparable to this project, surveys have been used in Australia for research on ECRs and other people in the sciences in Australia (Australian Society of Medical Research, 2016; Hardy et al., 2016; Kavallaris, 2008). These Australian surveys have focused on the lack of funding and the consequent loss of scientists to Australia and to science. Findings included responses to questions about hours worked and technical and research skills but there was no focus on broader professional development, mentoring, career planning or gender inequity. Again, these surveys did not look more widely to other factors affecting job satisfaction, however the survey conducted by Bell & Yates (2015) about Australian women in the STEM workforce was a valuable source of relevant questions. Ultimately questions pertinent to the Australian workforce were included from both Coates et al. (2008) and Bell & Yates (2015).

Table 2

Some Literature Reporting Surveys Relating to ECRs in STEM

Purpose	Year	# Respondents	Criteria	Countries	Survey Type	Authors *
Nature Salary and job satisfaction	Biennial	4344 (2018)	Working in a science career	Worldwide	Online	(Woolston, 2018b)
Nature PhD students career intentions	Biennial	6,300 (2019)	Graduate students in STEMM	Worldwide	Online	(Woolston, 2017, 2019)
Global Young Academy international	2013	650	ECRs up to 10 years postdoctoral	Worldwide	Online	(Friesenhahn & Beaudry, 2014)
Global Young Academy in ASEAN	2015	444	ECRs up to 10 years postdoctoral	Across Asia	Online	(Geffers et al., 2017)
Global Young Academy in Africa	2017	Survey (not yet published)		Across Africa	Online	(Coussens, 2017)
National Science Foundation	2015	6,827	ECRs in STEM up to 10 years postdoctoral	Mostly USA	Online	(Phou, 2017)
Vitae PIRLS	Biennial	3,790 (2017)	Principal investigators in STEMM	UK	Online	(Mellors-Bourne & Metcalf, 2017)
Vitae CROS	Biennial	7,657 (2017)	Higher ed staff 'primarily engaged in research	UK	Online	(Mellors-Bourne & Metcalf, 2017)
Higher Ed Academy Postgrad Research Experience	Annual	57,689 (2017)	Postgraduate research students	UK	Online	(Slight, 2017)
Australian Academic Profession Survey	2007	1,252	Australian university academics, all disciplines, all levels	Australia	Online	(Coates & Goedegebuure, 2007)
EMCR Forum	2013-14 and 2014-15	945 (2013-14) 284 (2014-15)	STEMM members of EMCR Forum, up to 15 years postdoctoral	Australia	Online	(Hardy et al., 2016)
ASMR		942	STEMM researchers, members of ASMR	Australia	Online	(Australian Society of Medical Research, 2016)
Women in the Science Workforce	2012	1298 respondents, (52% F 48% M)	biology biomed & chemistry-related research in Australia, all career stages	Australia	Online	(Bell & Yates, 2015)

*Authors as specified above; not the complete list

2.5.1.3 Journaling

Maintaining a journal was recommended as a data collection method suitable for mixed methods research and for this project, and I consulted texts (Howes, 2017; Samaras, 2011) which provided me with suggestions of ways to use journaling as a foundation for methodological refinement throughout the ongoing research journey. I was alerted to the benefits of critical thinking about my own assumptions (Mason, 2017), an important consideration due to my status as an inside researcher (Herrmann, 1989; Unluer, 2012), which meant I was coming to my research with a set of beliefs and potential biases. I employed the technique of journaling, asking myself the "difficult questions" throughout the life of the research project as had others on their research journeys (Adam, 2012; Unluer, 2012) and recorded efforts to maintain transparency (Grbich, 2018).The journal was also the means by which I recorded impromptu conversations and freestyle interviews with or about researchers and my observations of the research environment as I went about my work.

2.5.1.4 Data Analysis

In preparation for my data analysis, I explored the papers reporting studies which had used data collection techniques similar to mine (i.e semi-structured interviews, focus groups and survey) and thence the descriptions of their methodologies. There were many studies which had used one or more of these data collection methods; including some mixed methods studies which incorporated surveys and semi-structured interviews (Bell & Yates, 2015; Friesenhahn & Beaudry, 2014). It was helpful to read about and understand their approaches to their analyses, particularly when the subject matter was largely the same.

For analysis of the project data I employed thematic analysis for the qualitative data and I used descriptive and inferential statistics, structural equation modelling and logistic regression for the quantitative data. Much of the data analysis required understanding of the

software as well as the methods described in the literature. Examples of literature reviewed for each of these analysis types is mentioned below.

2.5.1.4.1 Thematic Analysis

I had had no previous experience of thematic analysis. Thematic analysis of the interviews and open text answers in the questionnaires, which are each described in Chapter 3, was carried out with the assistance of advice contained within a range of texts (Barnacle, 2005; Braun & Clarke, 2006; Mobius et al., 2014; Silverman, 2011). In addition to these texts describing the methods for thematic analysis I consulted papers reporting its use in specific projects. These included Bell & Yates (2015) and Tate (2020) who employed thematic analysis using NVivo software to analyse interview transcripts and Wiles (2006) and Webster et al. (2016) who similarly used NVivo to analyse transcripts of interviews and focus groups.

2.5.1.4.2 Descriptive Statistics

Much of the quantitative analysis of the on-line survey data (described in Chapter 3) was descriptive analysis conducted using either SPSS or Excel software. These software applications are commonly used for this purpose and there are many examples of survey analysis in the literature (Bell & Yates, 2015; European Science Foundation, 2015; Friesenhahn & Beaudry, 2014; Grinstein & Treister, 2018; Sinche, 2017). I was able to consult an SPSS reference manual (Heritage et al., 2018) to assist me with the actual software and to employ an on-line tool to establish statistical significance of my findings (Preacher, 2001).

2.5.1.4.3 Structural Equation Modelling

Factors relating to job satisfaction were analysed using structural equation modelling (SEM) in a process described in both Chapters 3 and 4. Again, I had no previous experience

SEM, a method I used to develop a model of job satisfaction for researchers in STEMM fields in academia. In order to understand the benefits of SEM, I read about the basics (Bacon & Bacon, 1997; Kline, 2016) and how to write up a modelling paper (Schreiber et al., 2006) and about other research projects using SEM (including Green, 2016; Hogan et al., 2015; Mamiseishvili & Rosser, 2011). The use of SEM, and particularly its use in the higher education workplace was the focus of a systematic review discussed in greater detail at the end of Chapter 3 (Section 3.9.1.2.1) and in Chapter 4, Section 4.4.

2.5.1.4.4 Logistic Regression

I employed binary logistic regression using the software SPSS to identify factors contributing to intention to leave, which is explained in Chapter 5. I was guided for this process by the text Heritage et al. (2018). A previous study (Ryan et al., 2012) had employed similar techniques to examine the relationship between various research-based factors and faculty intent to leave; another used it to predict job satisfaction amongst family medicine faculty (Krueger, 2017).

2.5.1.5 Validation of the Research

It became clear it would be necessary to demonstrate the validity of the research, for both quantitative and qualitative streams, and to demonstrate trustworthiness and dependability of the results, and sound advice was found in Denzin & Lincoln (2005), Kirk et al. (1986) and Robson (2002).

As this was a self-selected sample of study participants, I was aware of the need to do my best to provide a representative sample and to avoid sample bias (Greene, 2014; Kwak & Radler, 2002; Tourangeau, 2013). As I am employed in the medical research setting, I inevitably collected project data as an insider participant observer (i.e. as a member of a group

as well as the researcher) (Herrmann, 1989) which is considered to be "the most important and challenging instrument in qualitative studies" (Unluer, 2012, p.2); thus it was necessary to avoid undue influence from being an insider researcher (Greene, 2014; Mercer, 2007; Merriam et al., 2001; Rabbitt, 2003; Sheffield Hallam University, n.d.; Unluer, 2012). There are many advantages of being an insider researcher such as speaking the same insider language, understanding the local values, knowledge and taboos, knowing the formal and informal power structure, and knowing how to obtain permission to conduct the research, to interview, and to get access to records has been discussed in this literature. I have endeavoured to use reflexive techniques as advocated by Howes (2017) and other works which discuss insider research (Berger, 2015; Costley, 2010; Finefter-Rosenbluh, 2017; Greene, 2014; Samaras, 2011) to maintain an overall objective view of my potential biases.

Although women are seriously under-represented in some areas of scientific research (Bell & Yates, 2015), males and females are roughly equal in number in the scientific disciplines in academia overall (Australian Research Council, 2019). It was important to try to achieve an representative number of responses (Smith, 2008), even though other research showed it was likely that there would be more female respondents (Hardy et al., 2016). Likewise it was necessary to try to have respondents distributed across all STEMM disciplines in a manner reflective of their actual distribution (Australia Research Council, 2019), and to examine previously successful ways researchers had accessed the desired population, such as by using the "snowball effect" (Atkinson & Flint, 2001).

A further interest in potential sample bias came from the need for institutional consent to conduct the research with its staff members, and later I explored literature for similar situations (Middle et al., 1995) and about informed consent (Cugini, 2015; National Health and Medical Research Council, 2018b) and situations where response rates were affected by

the need for consent (Sax et al., 2003). The "gatekeepers" at the Australian universities had significantly influenced our study recruitment by their actions or inactions, so writing up this experience for a potential paper led me to examine research where the need for consent had influenced the recruitment or sample size of potential participants (Kearney et al., 1983; Miller & Boulton, 2007; Smajdor et al., 2009). I also explored the influence of gatekeepers on overall recruitment (Horan & Israel, 2016; Mander, 1992; Rogelberg & Stanton, 2007; Singh & Wassenaar, 2016; Walker & Read, 2011). No directly similar situations were found in the literature, but it was clear from these papers that the need for consent can have a profound influence on recruitment and sometimes might have unexpected impacts which perhaps outweigh the need for protection of the target population.

2.5.2 Summary of Literature Review for Research Methodology

In summary, in preparation for my project I explored the literature on research methodology and research methods I expected to be relevant to conducting a mixed methods study, and in particular, to the methods likely to be employed for such a study. Comparison with studies investigating similar populations internationally provided the majority of the relevant literature due to the relative lack of literature about the Australian workplace environment for ECRs in STEMM.

2.6 Conclusions for Chapter 2

As has been demonstrated above, there is only limited data about the overall situation for ECRs working in STEMM disciplines in Australia. Most research conducted in Australia has focused on the lack of funding and its consequences; there has been little apparent effort made to understand or improve the research workplace experience against the background of limited funding. There has been little research on the STEMM research environment as

experienced by the workers, or on opportunities for professional development or other workplace support for ECRs, or on their job satisfaction.

Recommendations to improve the ECR experience which have been developed in some countries and institutions mentioned above appear to offer opportunities to significantly increase job satisfaction and increase retention of researchers in STEMM. While there have been reports instigated by the Australian Government and bodies representing researchers in STEMM they have mostly been narrow in focus; there appears to have been little done to address the obvious challenges. This literature review clearly displays the need for further research into the workplace as experienced by ECRs in STEMM and into researcher development for people in these disciplines and suggests that appropriate themes for further investigation might include factors contributing to job satisfaction and intention to leave, as well as some specific features of the experiences and environment of the workplace for those ECRs.

Chapter 2 References

Abbott, A. (2020). Stress, anxiety, harassment: Huge survey reveals pressures of scientists' working lives. Nature. https://doi.org/10.1038/d41586-020-00101-9

ABC. (2019, June 20). Live: NSW Now: Another Sydney hospital hit with bullying claims, WIN closes three NSW newsrooms [Text]. ABC News. https://www.abc.net.au/news/2019-06-20/sydney-morning-briefing-thursday-june-20/11226042

Access Economics. (2003). Exceptional Returns. Published for Australian Society for Medical Research.

Access Economics. (2008). Exceptional Returns II. Published for Australian Society for Medical Research.

Adam, A. S. (2012). Managing Insider Issues Through Reflective Techniques—An insider researcher's journey. https://www.waikato.ac.nz/__data/assets/pdf_file/0009/167049/A-Adam-Managing-insider-issues-through-reflexive-techniques.pdf

Åkerlind, G. S. (2005). Postdoctoral researchers: Roles, functions and career prospects. Higher Education Research & Development, 24(1), 21–40. https://doi.org/10.1080/0729436052000318550

Åkerlind, G. S. (2008). An academic perspective on research and being a researcher: An integration of the literature. Studies in Higher Education, 33(1), 17–31. https://doi.org/10.1080/03075070701794775

Åkerlind, G. S. (2009). Postdoctoral research positions as preparation for an academic career. International Journal for Researcher Development, 1(1), 84–96. https://doi.org/10.1108/1759751X201100006

Amundsen, C., Turner, G., & McAlpine, L. (2013). Constructing post−PhD careers: Negotiating opportunities and personal goals. International Journal for Researcher Development, 4(1), 39–54. https://doi.org/10.1108/IJRD-01-2013-0002

Ashbaugh, J. L. (2003). The hard case for soft skills and retention. Staffing woes may be related to poorly developed soft skills in your leaders. Healthcare Executive, 18(2), 59–60.

Ashford, S. J., Lee, C., & Bobko, P. (1989). Content, Causes, and Consequences of Job Insecurity: A Theory-Based Measure and Substantive Test. The Academy of Management Journal, 32(4), 803–829. JSTOR. https://doi.org/10.2307/256569

Asmar, C. (1999). Is there a gendered agenda in academia? The research experience of female and male PhD graduates in Australian universities. Higher Education, 38, 255–273.

ASMR. (2015). Research Training Review. https://asmr.org.au/wp-content/uploads/library/Research%20Training%20Review_2015.pdf

Association of Australian Medical Research Institutes. (2017). Submission to NHMRC Research Review. Australian Association of Medical research Institutes.

Association of Australian Medical Research Institutes. (2018). Submission to Inquiry into Funding Australia's Research System. Australian Association of Medical Research Institutes.

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. Social Research Update, Summer 2001(33).

August, L., & Waltman, J. (2004). Culture, Climate, and Contribution: Career Satisfaction Among Female Faculty. Research in Higher Education, 45(2), 177–192. https://doi.org/10.1023/B:RIHE.0000015694.14358.ed

Austin, J. (2007a). Lab-Management Training—As Bad as We Suspected. Science. http://blogs.sciencemag.org/sciencecareers/2007/11/labmanagement-t.html

Austin, J. (2007b). Special Feature: Laboratory Management. Science. https://doi.org/10.1126/science.caredit.a0700159

Australia Research Council. (2019). State of Australian University Research 2018–19: ERA National Report. Australian Research Council. https://dataportal.arc.gov.au/ERA/NationalReport/2018/

Australian Academy of Science. (2019). EMCRs gain skills to build successful careers. Australian Academy of Science. https://www.science.org.au/academy-newsletter/july-2019-129/emcrs-gain-skills-build-successful-careers

Australian Research Council. (2019). Gender and the Research Workforce Section 2: Gender and the Research Workforce. Australian Research Council. https://dataportal.arc.gov.au/ERA/GenderWorkforceReport/2018/pages/section2/index.html?id=gender-snapshot-in-era

Australian Society of Medical Research. (2016). The 2016 ASMR Health and Medical Research Workforce Survey. Australian Society of Medical Research. https://asmr.org.au/wp-content/uploads/library/Workforce16.pdf

Bacon, L. D., & Bacon, L. (1997). Using Amos for structural equation modeling in market research. SPSS.

Bakker, A. B., & Demerouti, E. (2007). The Job Demands−Resources model: State of the art. Journal of Managerial Psychology, 22(3), 309–328. https://doi.org/10.1108/02683940710733115

Barnacle, R. (2005). Interpreting interpretation: A phenomenographical perspective on phenomenography. In J. A. Bowden & P. Green (Eds.), Doing developmental phenomenography. RMIT University Press.

Bartone, T., Kennedy, T., & McArdle, H. (2019). The AMA Gender Equity Summit Report. Australian Medical Association.

Basak, S. K., & Govender, D. (2015). Theoretical Framework Of The Factors Affecting University Academics Job Satisfaction. International Business & Economics Research Journal (IBER), 14(2). https://doi.org/10.19030/iber.v14i2.9167

Bavel, J. J. V., Gruber, J., Somerville, L. H., Lewis, N. A., Jr.Mar. 13, 2019, & Pm, 4:20. (2019, March 13). Three research-based lessons to improve your mentoring. Science AAAS. https://www.sciencemag.org/careers/2019/03/three-research-based-lessons-improve-your-mentoring

Bazeley, P., Kemp, L., Stevens, K., Asmar, C., Grbich, C., Marsh, H., & Bhathal, R. (1996). Waiting in the Wings: A Study of Early Career Academic Researchers in Australia. Australian Research Council and National Board of Employment Education and Training (NBEET). https://trove.nla.gov.au/version/217785130

Bazeley, Pat. (2003). Defining 'Early Career' in Research. Higher Education, 45(3), 257–279. https://doi.org/10.1023/A:1022698529612

Begley, C. G., & Ellis, L. M. (2012). Raise standards for preclinical cancer research. Nature, 483(7391), 531–533. https://doi.org/10.1038/483531a

Bell, D. (2016). The reality of STEM education, design and technology teachers' perceptions: A phenomenographic study. International Journal of Technology and Design Education, 26(1), 61–79. https://doi.org/10.1007/s10798-015-9300-9

Bell, S. (2009). Women in Science in Australia: Maximising productivity, diversity and innovation. Federation of Australian Scientific and Technological Societies (FASTS).

Bell, S., & Yates, L. (2015). Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne.

https://womeninscienceaust.org/2014/06/15/women-in-the-scientific-research-workforce-identifying-and-sustaining-the-diversity-advantage/

Benedictus, R., & Miedna, F. (2016). Fewer Numbers, Better Science. Nature, 538.

Bentley, P., Coates, H., Dobson, I., Goedegebuure, L., & Meek, V. L. (2013). Factors associated with job satisfaction amongst Australian university academics and future workforce implications. In Job Satisfaction around the Academic World. https://link.springer.com/chapter/10.1007/978-94-007-5434-8_3

Berger, R. (2015). Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. Qualitative Research, 15(2), 219–234. https://doi.org/10.1177/1468794112468475

Bexley, E., James, R., & Arkoudis, S. (2011). The Australian Academic Profession in Transition: Addressing the challenge of reconceptualising academic work and regenerating the academic workforce. Centre for Study of Higher Education, Commissioned by Department of Education, Employment and Workplace Relations. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0010/1490923/The_Academic_Profession_in_Transition_Sept2011.pdf

Blackburn, R. T., & Lawrence, J. H. (1995). Faculty at work: Motivation, expectation, satisfaction. Johns Hopkins University Press.

Bogle, D. (2018, June 27). How could universities and funders improve the situation for postdoctoral scientists? NatureJobs. http://blogs.nature.com/naturejobs/2018/06/27/how-could-universities-and-funders-improve-the-situation-for-postdoctoral-scientists/

Bogle, D., Compton-Daw, E., Elvidge, L., Gavaghan, D., Henstock, J., Jones, D., Normington, K., Rooney, C., Smith McGloin, R., Watson, D., & Wenham, M. (2018). Review of the Concordat to Support the Career Development of Researchers.

Boman, J. (2017). 2017 Career Tracking Survey of Doctorate Holders. European Science Foundation. www.esf.org

Bos, L. D., Langer, D., & Flood, E. (2017). New ECMC members: Early Career Forum. Breathe (Sheff), 13(1), 51–52. https://doi.org/10.1183/20734735.019816

Bosanquet, A., Mailey, A., Matthews, K. E., & Lodge, J. M. (2017). Redefining 'early career' in academia: A collective narrative approach. Higher Education Research & Development, 36(5), 890–902. https://doi.org/10.1080/07294360.2016.1263934

Boynton, P. M., & Greenhalgh, T. (2004). Selecting, designing, and developing your questionnaire. BMJ : British Medical Journal, 328(7451), 1312–1315.

Bozeman, B., & Gaughan, M. (2011). Job Satisfaction among University Faculty: Individual, Work, and Institutional Determinants. The Journal of Higher Education, 82(2), 154–186. https://doi.org/10.1080/00221546.2011.11779090

Bradley, D., Noonan, P., Nugent, H., & Scales, B. (2008). Review of Australian Higher Education: Final Report. Australian Government. https://www.mq.edu.au/__data/assets/pdf_file/0013/135310/bradley_review_of_australian_higher_education.pdf

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brown, G., & Edmunds, S. (2013). Undertaking Pedagogic Research using Qualitative Methods. In Getting started in pedagogic research within the STEM disciplines. University of Birmingham.

Browning, L., Thompson, K., & Dawson, D. (2014). Developing future research leaders: Designing early career researcher programs to enhance track record. International Journal for Researcher Development, 5(2), 123–134. https://doi.org/10.1108/IJRD-08-2014-0019

Browning, L., Thompson, K., & Dawson, D. (2016). It takes a village to raise an ECR: Organisational strategies for building successful academic research careers. International Journal for Researcher Development, 7(2). www.emeraldinsight.com/2048-8696.htm

Browning, L., Thompson, K., & Dawson, D. (2017). From early career researcher to research leader: Survival of the fittest? Journal of Higher Education Policy and Management, 39(4), 361–377. https://doi.org/10.1080/1360080X.2017.1330814

Carrington, K., & Pratt, A. (2003). How Far Have We Come? Gender Disparities in the Australian Higher Education System. Parliamentary Advice, Department of the Parliamentary Library.

Chesterman, C., Ross-Smith, A., & Peters, M. (2005). "Not doable jobs!" Exploring senior women's attitudes to academic leadership roles. Women's Studies International Forum, 28(2–3), 163–180. https://doi.org/10.1016/j.wsif.2005.04.005

Christian, K. (2018a). Keys to Running Successful Research Projects: All the Things They Never Teach You (1st ed.). Academic Press. https://www.elsevier.com/books/isbn/9780128131343

Christian, K. (2018b, September 4). Gender inequality in the sciences: Why is it still with us? NatureJobs. http://blogs.nature.com/naturejobs/2018/04/09/gender-inequality-in-the-sciences-why-is-it-still-with-us/

Coates, H., & Goedegebuure, L. (2007). The Australian Academic Profession in 2007 Survey Methodology and Response Analysis. Australian Council for Educational Research.

Coates, H., & Goedegebuure, L. (2010). The Real Academic Revolution: Why we need to reconceptualise Australia's future academic workforce. L H Martin Institute. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0007/2565070/Why-we-need-to-reconceptualise-Australias-future-academic-workforce.pdf

Coates, H., & Goedegebuure, L. (2012). Recasting the academic workforce: Why the attractiveness of the academic profession needs to be increased and eight possible strategies for how to go about this from an Australian perspective. Higher Education, 64(6), 875–889.

Coates, H., Goedegebuure, L., & Meek, V. L. (2015). Increasing the Attractiveness of the Academic Profession: A Challenge for Management. In U. Teichler & W. K. Cummings (Eds.), Forming, Recruiting and Managing the Academic Profession (pp. 297–315). Springer International Publishing. https://doi.org/10.1007/978-3-319-16080-1_16

Coates, H., Goedegebuure, L., Van der Lee, J., & Meek, L. (2008). The Australian academic profession in 2007: A first analysis of the survey results. Australian Council for Educational Research.

Collins, J., & Bulbeck, C. (1994). The casualisation of research postgraduate employment. Australian Government Publishing Service.

Corporate Leadership Council. (2004). Driving Performance and Retention through Employee Engagement: A quantitative analysis of effective engagement strategies. Corporate Executive Board Company.

Costley, C. (2010). Key Concepts for the Insider Researcher. http://methods.sagepub.com/book/doing-work-based-research/n1.xml

Coussens. (2017). GloSYS Africa Appendix 1_Survey and Consent v2.0 (Global Young Academy, Ed.).

Creswell, J. W. (2013). Qualitative Inquiry & Research Design: Choosing Among Five Approaches (3rd ed.). Sage.

Creswell, J. W. (2015). A Concise Introduction to Mixed Methods Research. Sage.

Cugini, M. (2015). Successfully Navigating the Human Subjects Approval Process. American Dental Hygienists' Association, 89(suppl 1), 54–56.

Daniels, K., & Harris, C. (2000). Work, Psychological Well-being and Performance. Occupational Medicine, 50(5), 304–309. https://doi.org/10.1093/occmed/50.5.304

Deloitte. (2016). Australia's health and medical research workforce—Expert people providing exceptional returns. Published for ASMR.

Denzin, N. K. (2012). Triangulation 2.0. Journal of Mixed Methods Research, 6(2), 80–88. https://doi.org/10.1177/1558689812437186

Denzin, N. K., & Lincoln, Y. K. (2005). The SAGE Handbook of Qualitative Research (3rd ed.). SAGE. https://epdf.pub/the-sage-handbook-of-qualitative-research.html

Denzin, N. K., & Lincoln, Y. S. (Eds.). (1994). Handbook of Qualitative Research (pp. xii, 643). Sage Publications, Inc.

Department of Industry, Innovation and Science. (2017). Australia's National Science Statement. Commonwealth of Australia. http://science.gov.au/NSS

Department of Industry Innovation and Science. (2018). Australia 2030: Prosperity through Innovation. Australian Government. https://www.industry.gov.au/data-and-publications/australia-2030-prosperity-through-innovation

Dick, R. V., Christ, O., Stellmacher, J., Wagner, U., Ahlswede, O., Grubba, C., Hauptmeier, M., Höhfeld, C., Moltzen, K., & Tissington, P. A. (2004). Should I Stay or Should I Go? Explaining Turnover Intentions with Organizational Identification and Job Satisfaction. British Journal of Management, 15, 351–360.

Diezmann, C. M., & Grieshaber, S. J. (2010a). The Australian story: Catalysts and inhibitors in the achievement of new women professors. AARE 2010 Conference Proceedings. AARE 2010 Conference, Melbourne, Australia. https://eprints.qut.edu.au/41176/1/41176.pdf

Diezmann, C. M., & Grieshaber, S. J. (2010b). Gender equity in the professoriate: A cohort study of new women professors in Australia. HERDSA Conference Proceedings, 14. https://eprints.qut.edu.au/45886/

Diezmann, C. M., & Grieshaber, S. J. (2013). Australian Women in the Academy. In W. Patton (Ed.), Conceptualising Women's Working Lives: Moving the Boundaries of Discourse (pp. 157–173). SensePublishers. https://doi.org/10.1007/978-94-6209-209-9_9

Doran, M. (2016). How to survive as a whistle-blower. Nature, 532(7599), 405–405. https://doi.org/10.1038/nj7599-405a

Dorenkamp, I., & Weiß, E.-E. (2018). What makes them leave? A path model of postdocs' intentions to leave academia. Higher Education, 75(5), 747–767. https://doi.org/10.1007/s10734-017-0164-7

Dudovskiy, J. (2014). Career planning and personal development plan. Research Methodology. https://research-methodology.net/career-planning-and-personal-development-plan-sample/#Personal_Career_Plan

Dunstone, M., & Williamson, B. (2016). Gender Equity: Current Issues, Best Practice and New Ideas.

[Editor, Nature]. (2016). Misspent Youth: Early-career researchers need fewer burdens and more support. Nature, 538, 427.

[Editor, Nature]. (2018a). Barriers in Science. Nature, 554, 561.

[Editor, Nature]. (2018b). Survey reveals highs and lows of a life in science. Nature, 562, 459. https://doi.org/10.1038/d41586-018-07149-8

Edwards, D., Bexley, E., & Richardson, S. (2011). Regenerating the Academic Workforce. The careers, intentions and motivations of higher degree research students in Australia. Findings of the National Research Student Survey. Australian Council for Educational Research. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0009/1490940/RAW_Combined.pdf

Edwards, D., & Smith, T. F. (2008). Supply, demand and approaches to employment by people with postgraduate research qualifications in science and mathematics: Literature Review and Data Analysis. Australian Council for Educational Research.

Else, H. (2018). A spate of bullying allegations have rocked some high- profile science institutions. Here's how researchers, universities and funders are dealing with the issue. Nature, 563, 616–618.

EMCR Forum. (2016a). Diiscussion Paper: Starting the conversation between academia and industry. Australian Academy of Science.

EMCR Forum. (2016b). EMCR Strategic Plan.

EMCR Forum. (2017). Research Opportunities and Performance Evidence Submission. https://www.science.org.au/supporting-science/science-policy/submissions-government/research-opportunity-performance-evidence

EMCR Forum. (2019, August). Professional development needs of EMCRs in Australia. https://www.surveymonkey.com/r/EMCR_professional_dev

European Science Foundation. (2015). Career Tracking Survey Pilot. European Science Foundation. http://www.esf.org/fileadmin/user_upload/esf/Career_Tracking_Pilot_Report_2015-05-28.pdf

European Science Foundation. (2017). Career Tracking Survey. European Science Foundation. http://www.esf.org/scientific-support/career-tracking-surveys-of-doctorate-holders/2017-career-tracking-survey-of-doctorate-holders/

Eysenbach, G. (2004). Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). Journal of Medical Internet Research, 6(3). https://doi.org/10.2196/jmir.6.3.e34

Finefter-Rosenbluh, I. (2017). Incorporating Perspective Taking in Reflexivity: A Method to Enhance Insider Qualitative Research Processes. International Journal of Qualitative Methods, 16(1), 1609406917703539. https://doi.org/10.1177/1609406917703539

Finkel, A. (2019, December 9). 'There is a problem': Australia's top scientist Alan Finkel pushes to eradicate bad science. The Conversation. http://theconversation.com/there-is-a-problem-australias-top-scientist-alan-finkel-pushes-to-eradicate-bad-science-123374

Flick, U. (2009). An Introduction to Qualitative Research. Sage.

Fogaça, N., & Coelho Junior, F. (2016). Is 'Happy Worker' More Productive. Management Studies, 4, 149–160. https://doi.org/10.17265/2328-2185/2016.04.002

Friesenhahn, I., & Beaudry, C. (2014). Global State of Young Scientists Project Report and Recommendations. Global Young Academy. https://globalyoungacademy.net/wp-content/uploads/2015/06/GYA_GloSYS-report_webversion.pdf

Funk, C., & Parker, K. (2018). Pew Report: Women and Men in STEM Often at Odds Over Workplace Equity. Pew Reserch Centre. go.nature.com/2esrhz5

Gardner, S. K. (2012). "I Couldn't Wait to Leave the Toxic Environment": A Mixed Methods Study of Women Faculty Satisfaction and Departure From One Research Institution. NASPA Journal About Women in Higher Education, 5(1), 71–95. https://doi.org/10.1515/njawhe-2012-1079

Gascoigne, T. (2012). Career support for researchers: Understanding needs and developing a best practice approach. Australian Council of Learned Academies Commissioned by the Department of Industry, Innovation, Science, Research and Tertiary Education.

Geffers, J., Beaudry, C., Yang, H.-C., Huang, F., Phanraksa, O., & Dominik, M. (2017). Global State of Young Scientists (GloSYS) in ASEAN: Creativity and Innovation of Young Scientists in ASEAN [Report]. Global Young Academy.

Gewin, V. (2016). Agents of Change. Nature, 538.

Gewin, V. (2017a). Tackling the Manel Problem. Nature Careers Blog. http://blogs.nature.com/naturejobs/2017/12/19/tackling-the-manel-problem/

Gewin, V. (2017b). The struggles of female and underrepresented scientists. Nature Jobs. http://blogs.nature.com/naturejobs/2017/11/21/the-struggles-of-female-and-underrepresented-scientists/

Gilliland, C. T., Sittampalam, G. S., Wang, P. Y., & Ryan, P. E. (2017). The translational science training program at NIH: Introducing early career researchers to the science and operation of translation of basic research to medical interventions. Biochemistry and Molecular Biology Education, 45(1), 13–24. https://doi.org/10.1002/bmb.20978

Given, L. (2018). The SAGE Encyclopedia of Qualitative Research Methods. https://doi.org/10.4135/9781412963909

Gonzalez, L. M., Wester, K. L., & Borders, L. D. (2019). Supports and barriers to new faculty researcher development. Studies in Graduate and Postdoctoral Education. https://doi.org/10.1108/SGPE-D-18-00020

Grbich, C. (2013). Qualitative Data Analysis: An Introduction. Sage.

Grbich, C. (2018). Course Notes for Foundations of Qualitative Methodologies, Data Collection and Analysis.

Green, T. (2016). A methodological review of structural equation modelling in higher education research. Studies in Higher Education, 41(12), 2125–2155. https://doi.org/10.1080/03075079.2015.1021670

Greene, J. C. (2008). Is Mixed Methods Social Inquiry a Distinctive Methodology? Journal of Mixed Methods Research, 2(1), 7–22. https://doi.org/10.1177/1558689807309969

Greene, M. J. (2014). On the Inside Looking In—Methodological Insights and Challenges in conducting qualitative insider research. The Qualitative Report, 19(29). https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1106&context=tqr

Grinstein, A., & Treister, R. (2018). The unhappy postdoc: A survey based study. F1000Research, 6, 1642. https://doi.org/10.12688/f1000research.12538.2

Grove, M., & Overton, T. (2013). Getting started in pedagogic research within the STEM disciplines. University of Birmingham.

Hagedorn, L. S. (2000). Conceptualizing faculty job satisfaction: Components, theories, and outcomes. In L. S. Hagedorn (Ed.), New Directions for Institutional Research (pp. 5–20). Jossey-Bass.

Handel, M. J. P., & Knight, K. (2017). Join the Conversation: Focus on early career researchers. Journal of Exerimental Biology, 220(Pt 12), 2132. https://doi.org/10.1242/jeb.163535

Hardy, M. C. (2014). Best Practices for Postdoctoral Progress. EMCR Forum.

Hardy, M. C., Carter, A., & Bowden, N. (2016). What do postdocs need to succeed? A survey of current standing and future directions for Australian researchers. Palgrave Communications, 2, 16093. https://doi.org/10.1057/palcomms.2016.93

Helbing, C. C., Verhoef, M. J., & Wellington, C. L. (1998). Finding identity and voice: A national survey of Canadian postdoctoral fellows. Research Evaluation, 7(1), 53–60. https://doi.org/10.1093/rev/7.1.53

Heritage, B., Allen, P., & Bennett, K. (2018). SPSS Statistics: A Practical Guide (Fourth). Cengage Learning Australia.

Herrmann, A. (1989). Participant Observer as 'Insider': Researching. Your Own Classroom. Annual Meeting of the Conference on College Composition and Communication, Seattle, WA.

Herzberg, F. (1964). The motivation-hygiene concept and problems of manpower. Personnel Administration, 27(1), 3–7.

Herzberg, F., Mausner, B., & Snyderman, B. B. (1959). The Motivation to Work (2nd ed.). John Wiley.

Hogan, V., Hogan, M., Hodgins, M., Kinman, G., & Bunting, B. (2015). An examination of gender differences in the impact of individual and organisational factors on work hours, work-life conflict and psychological strain in academics. The Irish Journal of Psychology. http://dx.doi.org/10.1080/03033910.2015.1011193

Holman, L., Stuart-Fox, D., & Hauser, C. E. (2018). The gender gap in science: How long until women are equally represented? PLOS Biology, 16(4), e2004956. https://doi.org/10.1371/journal.pbio.2004956

Horan, J., & Israel, M. (2016). Beyond the legal barriers: Institutional gatekeeping and real jury research. Australian & New Zealand Journal of Criminology, 49(3), 422–436. https://doi.org/10.1177/0004865815577768

Howes, L. M. (2017). Developing the Methodology for an Applied, Interdisciplinary Research Project: Documenting the Journey Toward Philosophical Clarity. Journal of Mixed Methods Research, 11(4), 450–468. https://doi.org/10.1177/1558689815622018

Iacovides, A., Fountoulakis, K. N., Kaprinis, S., & Kaprinis, G. (2003). The relationship between job stress, burnout and clinical depression. Journal of Affective Disorders, 75(3), 209–221. https://doi.org/10.1016/s0165-0327(02)00101-5

Jahn, R. (2018). Max Planck Guidelines on the postdoc stage. Max Planck. www.mpg.de/guidelines-postdocs

Jelen, A. (2018). Expert Interviews for Qualitative Data Generation. ECPR Summer School. https://ecpr.eu/Events/PanelDetails.aspx?PanelID=7487&EventID=125

Johnson, R. B., Onwuegbuzie, A. J., & Turner, Li. A. (2007). Toward a Definition of Mixed Methods Research. Journal of Mixed Methods Research, 1(2), 112–133.

Johnsrud, L. K., & Rosser, V. J. (2002). Faculty members' morale and their intentions to leave: A multilevel explanation. The Journal of Higher Education, 71(1), 34–59.

Karlin, L. (2019). Wellcome—Research Culture: Extended Review. Shift Learing.

Kavallaris, M. (2008). Perceptions in health and medical research careers: The Australian Society for Medical Research Workforce Survey. Medical Journal of Australia, 188, 520–524.

Kearney, K. A., Hopkins, R. H., Mauss, A. L., & Weisheit, R. A. (1983). Sample Bias Resulting from a Requirement for Written Parental Consent. Public Opinion Quarterly, 47(1), 96–102. https://doi.org/10.1086/268769

Kinman, G. (2014). Doing More with Less? Work and Wellbeing in Academics. Somatechnics, 219–235. https://doi.org/10.3366/soma.2014.0129

Kinman, G., & Wray, S. (2014). Work-related wellbeing in UK Higher Education—2014. University and College Union (UCU).

Kinman, G., & Wray, S. (2020). Wellbeing in academic employees– a benchmarking approach. In Handbook of Research on Stress and Well-being in the Public Sector. Edward Elgar Publishing Limited.

Kirk, J., Miller, M. L., & Miller, M. L. (1986). Reliability and Validity in Qualitative Research. SAGE.

Kline, R. B. (2016). Principles and practice of structural equation modeling (4th ed.). Guilford Press.

Kornhauser, A. (1965). Mental health of the industrial worker: A Detroit study (pp. xi, 354). John Wiley.

Krueger, P. (2017). Predictors of Job Satisfaction Among Academic Family Medicine Faculty. Canadian Family Physician, 63.

Kwak, N., & Radler, B. (2002). A Comparison Between Mail and Web Surveys: Response Pattern, Respondent Profile, and Data Quality. 17.

Lacy, F. J., & Sheehan, B. A. (1997). Job satisfaction among academic staff: An international perspective. Journal of Higher Education, 34(3), 305–322.

Lashuel, H. A. (2020). The busy lives of academics have hidden costs—And universities must take better care of their faculty members. Nature. https://doi.org/10.1038/d41586-020-00661-w

Laudel, G., & Gläser, J. (2008). From apprentice to colleague: The metamorphosis of early career researchers. Higher Education, 55(3), 387–406. https://doi.org/10.1007/s10734-007-9063-7

Lechuga, V. M. (2012). Latino Faculty in STEM Disciplines: Motivation to Engage in Research Activities. Journal of Latinos and Education, 11(2), 107–123. https://doi.org/10.1080/15348431.2012.659564

Lee, A. (2007). Nature's Guide to Mentors. Nature, 447, 791–797.

Lee, A. (2020). Adrian Lee mentoring website [Personal communication].

Lee, T. W., & Mowday, R. T. (1987). Voluntarily leaving an organization: An empirical investigation of Steers and Mowday's model of turnover. Academy of Management Journal, 30(4), 721–743. https://doi.org/10.2307/256157

Leiserson, C. E., & McVinney, C. (2015). Science professors need leadership training. Nature, 523, 279–281.

LERU. (2018). Delivering talent: Careers of researchers inside and outside academia LERU Position Paper 2018. LERU. www.leru.org

Levine, R. B., Lin, F., Kern, D. E., Wright, S. M., & Carrese, J. (2011). Stories From Early-Career Women Physicians Who Have Left Academic Medicine: A Qualitative Study at a Single Institution: Academic Medicine, 86(6), 752–758. https://doi.org/10.1097/ACM.0b013e318217e83b

Ley, T. J., & Hamilton, B. H. (2008). The Gender Gap in NIH Grant Applications. Science, 322(5907), 1472–1474. https://doi.org/10.1126/science.1165878

Liang, R., Dornan, T., & Nestel, D. (2019). Why do women leave surgical training? A qualitative and feminist study. The Lancet, 393(10171), 541–549. https://doi.org/10.1016/S0140-6736(18)32612-6

Liao, S.-H., Hu, D.-C., & Chung, H.-Y. (2009). The relationship between leader-member relations, job satisfaction and organizational commitment in international tourist hotels in Taiwan. The International Journal of Human Resource Management, 20(8), 1810–1826. https://doi.org/10.1080/09585190903087222

Liénard, J. F., Achakulvisut, T., Acuna, D. E., & David, S. V. (2018). Intellectual synthesis in mentorship determines success in academic careers. Nature Communications, 9. https://doi.org/10.1038/s41467-018-07034-y

Lok, P., & Crawford, J. (2004). The effect of organisational culture and leadership style on job satisfaction and organisational commitment: A cross‐national comparison.

Journal of Management Development, 23(4), 321–338. https://doi.org/10.1108/02621710410529785

Lopes, J., Ranieri, V., Lambert, T., Pugh, C., Barratt, H., Fulop, N. J., Rees, G., & Best, D. (2017). The clinical academic workforce of the future: A cross-sectional study of factors influencing career decision-making among clinical PhD students at two research-intensive UK universities. BMJ Open, 7(8), e016823. https://doi.org/10.1136/bmjopen-2017-016823

Maher, B., & Anfres, M. S. (2016). Under Pressure. Nature, 538, 444–445.

Mamiseishvili, K., & Rosser, V. J. (2011). Examining the Relationship between Faculty Productivity and Job Satisfaction. Journal of the Professoriate, 5(2), 100–132.

Manathunga, C., Lant, P., & Mellick, G. (2007). Developing professional researchers: Research students' graduate attributes. Studies in Continuing Education, 29(1), 19–36. https://doi.org/10.1080/01580370601146270

Manathunga, C., Pitt, R., & Critchley, C. (2009). Graduate attribute development and employment outcomes: Tracking PhD graduates. Assessment and Evaluation in Higher Education, 34(1), 91–103.

Mander, R. (1992). Seeking approval for research access: The gatekeeper's role in facilitating a study of the care of the relinquishing mother. Journal of Advanced Nursing. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2648.1992.tb02818.x

Manger, T., & Eikeland, O.-J. (1990). Factors Predicting Staff's Intentions to Leave the University. Higher Education, 19(3), 281–291. JSTOR.

Marceau, J., & Preston, H. (1996). Taking the lead: The ARC Fellowships Scheme in Australia. Australian Government Publishing Service.

Marceau, J., & Preston, H. (1997). Nurturing National Talent: The Australian Research Council's Fellowship Scheme. Prometheus, 15(1), 41–53. https://doi.org/10.1080/08109029708632049

Martinez, E. D., Botos, J., Dohoney, K. M., Geiman, T. M., Kolla, S. S., Olivera, A., Qiu, Y., Rayasam, G. V., Stavreva, D. A., & Cohen‐Fix, O. (2007). Falling off the academic bandwagon. EMBO Reports, 8(11), 977–981. https://doi.org/10.1038/sj.embor.7401110

Maslow, A. H. (1943). A theory of human motivation. Psychological Review, 50(4), 370–96. https://doi.org/10.1037/h0054346

Maslow, A. H. (1954). Motivation and Personality. Harper.

Maslow, A. H. (1970). Motivation and personality. Harper & Row.

Mason, J. (2017). Qualitative Researching. SAGE.

Mayer, A. L., & Tikka, P. M. (2008). Family‐friendly policies and gender bias in academia. Journal of Higher Education Policy and Management, 30(4), 363–374. https://doi.org/10.1080/13600800802383034

McAlpine, L., & Emmioğlu, E. (2015). Navigating careers: Perceptions of sciences doctoral students, post-PhD researchers and pre-tenure academics. Studies in Higher Education, 40(10), 1770–1785. https://doi.org/10.1080/03075079.2014.914908

McCabe, J., & Schubert, M. (2020). 2020-21 Professional Scientists Employment and Remuneration Report FINAL.pdf. Professional Scientists Australia. https://apesma.informz.net/apesma/data/images/2020-21%20Professional%20Scientists%20Employment%20and%20Remuneration%20Report%20FINAL.pdf

McCarthy, P. X., & Wieke, M. (2019). Advancing Australia's Knowledge Economy. University of Melbourne on behalf of AMSI and CSIRO Data61's Ribit net. https://amsi.org.au/publications/advancing-australias-knowledge-economy/

McDonald, D. J., & Makin, P. J. (2000). The psychological contract, organisational commitment and job satisfaction of temporary staff. Leadership & Organization Development Journal, 21(2), 84–91. https://doi.org/10.1108/01437730010318174

McGagh, J., Marsh, H., Western, M., Thomas, P., Hastings, A., Mihailova, M., & Wenham, M. (2016). Review of Australia's Research Training System: Final Report. Australian Council of Learned Academies.

McKeon, S., Alexander, E., Frazer, I., Ferris, B., Brodaty, H., & Little, M. (2013). Strategic Review of Health and Medical Research – Better Health Through Research. Australian Government, Department of Health and Aging.

Meacham, S. (2016). Health and Medical Research—The heart of a fully integrated healthcare system. Australian Healthcare and Hospitals Association.

Mellors-Bourne, R., & Metcalf, J. (2017). Five Steps Forward: Progress in implementing the Concordat to Support the Career Development of Researchers 2008-2017. Careers Research & Advisory Centre, Vitae.

Mercer, J. (2007). The challenges of insider research in educational institutions: Wielding a double−edged sword and resolving delicate dilemmas. Oxford Review of Education, 33(1), 1–17. https://doi.org/10.1080/03054980601094651

Merriam, S. B., Johnson-Bailey, J., Lee, M.-Y., Kee, Y., Ntseane, G., & Muhamad, M. (2001). Power and positionality: Negotiating insider/outsider status within and across cultures. International Journal of Lifelong Education, 20(5), 405–416. https://doi.org/10.1080/02601370120490

Meyer, J. P., & Maltin, E. R. (2010). Employee commitment and well-being: A critical review, theoretical framework and research agenda. Journal of Vocational Behavior, 77(2), 323–337. https://doi.org/10.1016/j.jvb.2010.04.007

Middle, C., Johnson, A., Petty, T., Sims, L., & Macfarlane, A. (1995). Ethics approval for a national postal survey: Recent experience. BMJ, 311(7006), 659–660. https://doi.org/10.1136/bmj.311.7006.659

Miller, J. M., & Feldman, M. P. (2015). Isolated in the Lab: Examining Dissatisfaction with Postdoctoral Appointments. The Journal of Higher Education, 86(5), 697–724. https://doi.org/10.1353/jhe.2015.0029

Miller, T., & Boulton, M. (2007). Consenting to what? Issues of access, gate-keeping and informed consent. 2nd ed. Social Science & Medicine, 65, 2199–2211.

Misra, J., Lundquist, J. H., & Templer, A. (2012). Gender, Work Time, and Care Responsibilities Among Faculty. Sociological Forum, 27(2), 300–323. https://doi.org/10.1111/j.1573-7861.2012.01319.x

Mobius, M., Niederle, M., Niehaus, P., & Rosenblat, T. (2014). Managing Self-Confidence. National Bureau of Economic Research Working Paper.

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. Proceedings of the National Academy of Sciences, 109(41), 16474–16479. https://doi.org/10.1073/pnas.1211286109

Nash, M., & Moore, R. (2018). 'I was completely oblivious to gender': An exploration of how women in STEMM navigate leadership in a neoliberal, post-feminist context. Journal of Gender Studies, 28(4), 449–461. https://doi.org/10.1080/09589236.2018.1504758

National Academies of Sciences. (2018). The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through. https://doi.org/10.17226/25008

National Health and Medical Research Council. (2016). Consultation Paper Structural Review. NHMRC.

National Health and Medical Research Council. (2017a). Consultation Summary Report. NHMRC.

National Health and Medical Research Council. (2017b). Funding Top Female Researchers.

National Health and Medical Research Council. (2018a). National Health and Medical Research Council Corporate Plan 2017–18. National Health and Medical Research Council.

National Health and Medical Research Council. (2018b). National Statement on Ethical Conduct in Human Research (2007)—Updated 2018. Commonwealth of Australia, Canberra. https://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018

National Health and Medical Research Council. (2019). Investigator grants 2019 outcomes factsheet. https://www.nhmrc.gov.au/funding/data-research/outcomes-funding-rounds

National Health and Medical Research Council. (2020). 2019 Survey of research culture in Australian NHMRC-funded institutions. https://www.nhmrc.gov.au/research-policy/research-quality#download

National Research Council. (2005). Bridges to Independence: Fostering the Independence of New Investigators in Biomedical Research. National Academies Press. https://doi.org/10.17226/11249

National Tertiary Education Union. (2012). Independent Inquiry into Insecure Work: Submission of National Tertiary Education Union. https://www.actu.org.au/media/349566/national-tertiary-education-union.pdf

NBEET. (2012). The Research Education Experience: Investigating Higher Degree by Research Candidates' Experiences in Australian Universities [Council of Postgraduate Associations]. Australian Government, Department of Industry, Innovation, Science, Research and Tertiary Education. http://www.voced.edu.au/content/ngv%3A24757

Nogrady, B. (2019). Sexual harassment rife in Australian science, suggests first workplace survey. Nature, 567, 14–15. https://doi.org/10.1038/d41586-019-00736-3

Norton. (2016). Mapping Higher Education in Australia 2016. Grattan Institiute.

Norton, A., Cherastidtham, I., & Mackey, W. (2018). Mapping Australian higher education 2018. Grattan Institute. https://grattan.edu.au/report/mapping-australian-higher-education-2018/

Ogdie, A., Sparks, J. A., Angeles-Han, S. T., Bush, K., Castelino, F. V., Golding, A., Jiang, Y., Kahlenberg, J. M., Kim, A. H. J., Lee, Y. C., Machireddy, K., Ombrello, M. J., Shah, A. A., Wallace, Z. S., Nigrovic, P. A., Makris, U. E., & American College of Rheumatology Early Career Investigator Subcommittee, R. (2017). Barriers and facilitators of mentoring for trainees and early career investigators in rheumatology research: Current state, identification of needs, and roadmap to an inter-institutional adult rheumatology mentoring program. Arthritis Care Res (Hoboken), 67(9). https://doi.org/10.1002/acr.23286

Ognibene, F. P., Gallin, J. I., Baum, B. J., Wyatt, R. G., & Gottesman, M. M. (2016). Outcomes From the NIH Clinical Research Training Program: A Mentored Research Experience to Enhance Career Development of Clinician-Scientists. Academic Medicine. https://doi.org/10.1097/ACM.0000000000001245

O'Laughlin, E. M., & Bischoff, L. G. (2005). Balancing Parenthood and Academia: Work/Family Stress as Influenced by Gender and Tenure Status. Journal of Family Issues, 26(1), 79–106. https://doi.org/10.1177/0192513X04265942

Oni, T. (2016). Let Researchers Try New Paths. Nature, 538.

Ovseiko, P. V., Chapple, A., Edmunds, L. D., & Ziebland, S. (2017). Advancing gender equality through the Athena SWAN Charter for Women in Science: An exploratory study of women's and men's perceptions. Health Research Policy and Systems, 15(1), 12. https://doi.org/10.1186/s12961-017-0177-9

Payne, D. (2019). The professional advisers who can help you to move from academia to industry. Nature, 567, 135. https://doi.org/10.1038/d41586-019-00747-0

Petersen, E. B. (2011). Staying or going? Australian early career researchers' narratives of academic work, exit options and coping strategies. Australian Universities Review, 53, 34–42.

Petsko, G., Anderson-Thompkins, S., Bernard, H. R., Greider, C., Plummer, J., Reece, E. A., Schwartz, N., Stephan, P., Tracey, L., Turner, M., Woodall, A., & Woodard, J. (2014). The Postdoctoral Experience Revisited. The National Academies Press. https://doi.org/10.17226/18982

Phillips, P., & Meacham, S. (2015). Submission to: Review of Australia's Research Training System. ASMR.

Phou, K. (2017). Profile of Early Career Doctorates: 2015 (Infobrief). National Science Foundation. https://www.nsf.gov/statistics/

Podsakoff, P. M., MacKenzie, S. B., Paine, J. B., & Bachrach, D. B. (2000). Organizational Citizenship Behaviors: A Critical Review of the Theoretical and Empirical Literature and Suggestions for Future Research. Journal of Management, 26(3), 516–563.

Powell, K. (2016a). Young, Talented and Fed Up. Nature, 538.

Powell, K. (2016b). Hard work, little reward. Nature. http://www.nature.com.ezproxy.federation.edu.au/news/hard-work-little-reward-nature-readers-reveal-working-hours-and-research-challenges-1.20933

Powell, K. (2018). A kinder kind of science. Nature, 553, 367–369.

Preacher, K. J. (2001). Calculation for the chi-square test: An interactive calculation tool for chi-square tests of goodness of fit and independence [Computer software]. http://www.quantpsy.org/chisq/chisq.htm

Prinz, C. (2016). Helping hands: Organizations, institutions work to assist and mentor early career investigators. Cancer, 122(2), 173–174. https://doi.org/10.1002/cncr.29860

Quinlan, K. M. (1999). Enhancing Mentoring and Networking of Junior Academic Women: What, why, and how? Journal of Higher Education Policy and Management, 21(1), 31–42. https://doi.org/10.1080/1360080990210103

Rabbitt, E. (2003). The implications of conducting research in your home locale. Australian Association for Research in Education.

Reynolds, A. C., O'Mullan, C., Pabel, A., Martin-Sardesai, A., Alley, S., Richardson, S., Colley, L., Bousie, J., & McCalman, J. (2018). Perceptions of success of women early career researchers. Studies in Graduate and Postdoctoral Education, 9(1), 2–18. https://doi.org/10.1108/SGPE-D-17-00019

Rickard, K., Crowther, A., & Gargano, S. (2018). Professionals Australia (2018). All Talk: Gap between policy and practice a key obstacle to gender equity in STEM - 2018 Women in STEM Professions Survey Report. Professionals Australia. http://www.professionalsaustralia.org.au/professional-women/wp-content/uploads/sites/48/2018/08/2018-Women-in-STEM-Survey-Report_web.pdf

Robbins, C. K., & LePeau, L. A. (2018). Seeking “better ways”: Early career faculty researcher development. Studies in Graduate and Postdoctoral Education, 9(2), 113–126. https://doi.org/10.1108/SGPE-D-17-00029

Robbins, S. P., & Judge, T. (2012). Organizational behavior (13th ed). Upper Saddle River, NJ : Pearson/Prentice Hall. /content/one-dot-com/one-dot-com/us/en/higher-education/product.html

Roberts, G. (2002). SET for Success: The Report of Sir Gareth Roberts’ Review (p. 218). Institute for Employment Studies (IES), HM Treasury UK. http://www.employment-studies.co.uk/resource/set-success-report-sir-gareth-roberts-review

Robson, C. (2002). Real World Research (2nd ed.). Blackwell Publishers. https://www.bookdepository.com/Real-World-Research-Colin-Robson/9780631213055

Rochen Renner, B. (n.d.). LibGuides: Altac (Alternative Academic) Careers: STEM Resources. Retrieved 17 March 2020, from https://guides.lib.unc.edu/c.php?g=216166&p=1661253

Rogelberg, S. G., & Stanton, J. M. (2007). Introduction: Understanding and Dealing With Organizational Survey Nonresponse. Organizational Research Methods, 10(2), 195–209. https://doi.org/10.1177/1094428106294693

Rosser, V. J., & Tabata, L. N. (2010). An Examination of Faculty Work: Conceptual and Theoretical Frameworks in the Literature. In J. C. Smart (Ed.), Higher Education: Handbook of Theory and Research: Volume 25 (pp. 449–475). Springer Netherlands. https://doi.org/10.1007/978-90-481-8598-6_12

Ryan, J. F., Healy, R., & Sullivan, J. (2012). Oh, won’t you stay? Predictors of faculty intent to leave a public research university. Higher Education, 63(4), 421–437. https://doi.org/10.1007/s10734-011-9448-5

Samaras, A. (2011). Understanding self-study research—What and why. In Self-study teacher research: Improving your practice through collaborative enquiry. (pp. 3–22). Sage.

Sauermann, H., & Roach, M. (2016). Why pursue the postdoc path? Science, 352(6286), 663–664. https://doi.org/10.1126/science.aaf2061

Sax, L. J., Gilmartin, S. K., & Bryant, A. N. (2003). Assessing Response Rates and Nonresponse Bias in Web and Paper Surveys. Research in Higher Education, 44(4), 409–432. https://doi.org/10.1023/A:1024232915870

Schofield, D. (2009). Planning the Health and Medical Research Workforce 2010-2019. ASMR. https://asmr.org.au/wp-content/uploads/library/workforce09.pdf

Schofield, D., & Meacham, S. (2011). A crisis in the making? Education, ageing populations and the future of the medical research workforce. Medical Education, 45(2), 200–207.

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting Structural Equation Modeling and Confirmatory Factor Analysis Results: A Review. The Journal of Educational Research, 99(6), 323–338. https://doi.org/10.3200/JOER.99.6.323-338

Schuster, J. H., & Finkelstein, M. J. (2008). The American Faculty: The Restructuring of Academic Work and Careers. Johns Hopkins University Press.

Science and Technology Australia. (2019). STA Submission: Sexual harassment in the workplace. https://scienceandtechnologyaustralia.org.au/wp-content/uploads/2019/02/STA-Submission-Sexual-harassment-in-the-workplace-.pdf

Science in Australia Gender Equity. (2015). About Science in Australia Gender Equity (SAGE). http://www.sciencegenderequity.org.au/

Science in Australia Gender Equity. (2018). Putting Gender on your Agenda (SAGE). https://www.sciencegenderequity.org.au/wp-content/uploads/2018/12/SAGE_Report_44pp_ SCREEN.pdf.

Scott, K. D., & Taylor, G. S. (1985). An Examination of Conflicting Findings on the Relationship between Job Satisfaction and Absenteeism: A Meta-Analysis. The Academy of Management Journal, 28(3), 599–612. JSTOR. https://doi.org/10.2307/256116

Sheffield Hallam University. (n.d.). Insider Research Guidelines. https://www.shu.ac.uk/research/quality/ethics-and-integrity/guidance-and-legislation

Shine, J., Bradlow, H., O'Reilly, S., & Godfrey, B. (2019). Women in STEM Decadal Plan (Australian Academy of Science) (p. 62). Australian Academy of Science. https://www.science.org.au/support/analysis/decadal-plans-science/women-in-stem-decadal-plan

Shmatko, N., Katchanov, Y., & Volkova, G. (2020). The value of PhD in the changing world of work: Traditional and alternative research careers. Technological Forecasting and Social Change, 152, 119907. https://doi.org/10.1016/j.techfore.2019.119907

Signoret, C., Ng, E., Da Silva Heil, S., Tack, A., & Voss, U. (2018). Well-Being of Early-Career Researchers: Insights from a Swedish Survey. Higher Education Policy. https://www.researchgate.net/publication/323073459_Well-Being_of_Early-Career_Researchers_Insights_from_a_Swedish_Survey

Silverman, D. (2011). Interpreting Qualitative Data. Sage.

Sinche, M. (2017). An evidence-based evaluation of transferrable skills and job satisfaction for science PhDs. PLoS ONE, 12(9), 1–16.

Singh, S., & Wassenaar, D. (2016). Contextualising the role of the gatekeeper in social science research. South African Journal of Bioethics and Law, 9(1), 42. https://doi.org/10.7196/SAJBL.2016.v9i1.465

Skakni, I., & McAlpine, L. (2017). Post-PhD researchers' experiences: An emotionally rocky road. Studies in Graduate and Postdoctoral Education, 8(2), 205–219. https://doi.org/10.1108/SGPE-D-17-00026

Slight, C. (2017). Postgraduate Research Experience Survey 2017 Experiences and personal outlook of postgraduate researchers. Higher Education Academy. https://www.heacademy.ac.uk/knowledge-hub/postgraduate-research-experience-survey-report-2017

Smajdor, A., Sydes, M. R., Gelling, L., & Wilkinson, M. (2009). Applying for ethical approval for research in the United Kingdom. BMJ, 339, b4013. https://doi.org/10.1136/bmj.b4013

Smith, D. K. (2020). The race to the bottom and the route to the top. Nature Chemistry, 12, 101–103.

Smith, G. (2008). Does gender influence online survey participation?: A record-linkage analysis of university faculty online survey response behavior. ERIC Document Reproduction Service No. ED 501717. https://works.bepress.com/grinell_smith/5/

Sohn, E. (2018a). Science and Sickness. Nature, 553, 239–241.

Sohn, E. (2018b). Child on the Horizon. Nature, 554, 393–395.

Sony, M., & Mekoth, N. (2016). The relationship between emotional intelligence, frontline employee adaptability, job satisfaction and job performance -. Journal of Retailing and Consumer Services, 30, 20–32.

Stürmer, S., Oeberst, A., Trötschel, R., & Decker, O. (2017). Early-Career Researchers' Perceptions of the Prevalence of Questionable Research Practices, Potential Causes, and Open Science. Social Psychology, 48(6), 365–371. https://doi.org/10.1027/1864-9335/a000324

Sugars, J. (2016). Vitae Research Development Framework.

Sugimoto, C. R., Ni, C., West, J., & Lavriere, V. (2014). The Academic Advantage: Gender Disparities in Patenting. PLOSOne, 10(5).

Susi, T. (2018). Young Academy of Europe Members Survey 2018: Initial Analyses. 18.

Sutherland, K. A. (2018a). Chapter 5: Satisfaction Among Early Career Academics in New Zealand. In Early Career Academics in New Zealand: Challenges and Prospects in Comparative Perspective. Springer.

Sutherland, K. A. (2018b). Chapter 8: Resources, Training and Support for Early Career Academics. In Early Career Academics in New Zealand: Challenges and Prospects in Comparative Perspective. Springer.

Sutherland, K. A. (2018c). Conclusion: Challenges and Prospects for Early Career Academics. In Early Career Academics in New Zealand: Challenges and Prospects in Comparative Perspective. Springer.

Sutherland, K. A. (2018d). Early Career Academics in New Zealand: Challenges and Prospects in Comparative Perspective. Springer International Publishing. https://www.springer.com/gp/book/9783319618296

Sutherland, K. A. (2018e. Holistic academic development: Is it time to think more broadly about the academic development project? International Journal for Academic Development, 23(4), 261–273. https://doi.org/10.1080/1360144X.2018.1524571

Tate, C. (2020). Early career researchers: The role of project management, mentors and the pathway to success. Massey University.

Thomas, J., Thomas, C., & Smith, K. (2019). The Challenges for Gender Equity and Women in Leadership in a Distributed University in Regional Australia. Social Sciences, 8(6), 165. https://doi.org/10.3390/socsci8060165

Thompson, J., Pearson, M., Akerlind, G., Hooper, J., & Mazur, N. (2001). Postdoctoral training and employment outcomes. Department of Education, Training and Youth Affairs.

Tourangeau, R. (2013). Nonresponse in Social Science Surveys: A Research Agenda: National Research Council of the National Academies. National Academies Press. https://doi.org/10.17226/18293

Tracy, S. (2019). Qualitative Research Methods: Collecting Evidence, Crafting Analysis, Communicating Impact (2nd ed.). Wiley-Blackwell. https://www.wiley.com/en-us/Qualitative+Research+Methods%3A+Collecting+Evidence%2C+Crafting+Analysis%2C+Communicating+Impact%2C+2nd+Edition-p-9781119390800

Trivellas, P., Reklitis, P., & Platis, C. (2013). The Effect of Job Related Stress on Employees' Satisfaction: A Survey in Health Care. Procedia - Social and Behavioral Sciences, 73, 718–726. https://doi.org/10.1016/j.sbspro.2013.02.110

Turner, C. S. V., & Myers, S. L. (2000). Faculty of Color in Academe: Bittersweet Success. Pearson. https://www.pearson.com/us/higher-education/program/Turner-Faculty-of-Color-in-Academe-Bittersweet-Success/PGM5737.html

Unluer, S. (2012). Being an Insider Researcher while Conducting Case Study Research. Qualitative Report, 17. https://eric.ed.gov/?id=EJ981455

Van Noorden, R. (2018). Some hard numbers on science's leadership problems. Nature, 557, 294–296.

Vance, E. A., Tanenbaum, E., Kaur, A., Otto, M. C., & Morris, R. (2017). An Eight-Step Guide to Creating and Sustaining a Mentoring Program. The American Statistician, 71(1), 23–29. https://doi.org/10.1080/00031305.2016.1251493

Vaux, D. (2013, July 25). From fraud to fair play: Australia must support research integrity. The Conversation. http://theconversation.com/from-fraud-to-fair-play-australia-must-support-research-integrity-15733

Vitae. (2008). The Concordat to Support the Career Development of Researchers.

Vitae. (2011). Researcher Development Framework. https://www.vitae.ac.uk/researchers-professional-development/about-the-vitae-researcher-development-framework

Vitae. (2012). Transforming Professional Development for Researchers: Vitae 2012 Report Achievements Vitae 2008-2012. CRAC: The Career Development Organisation.

Vitae. (2013). Transforming Professional Development for Researchers: Vitae Achievements and Impacts 2008-2012. https://www.vitae.ac.uk/about-us/vitae-publications/reports/report-achievements-vitae-2008-2012.pdf

Vitae. (2019). The Concordat to Support the Career Development of Researchers—Vitae Website. https://www.vitae.ac.uk/policy/concordat/full

Walker, K. (2018, November). Science gender pay gap too wide and job insecurity persists: New report. Science and Technology Australia. https://scienceandtechnologyaustralia.org.au/science-gender-pay-gap-too-wide-and-job-insecurity-persists-new-report/

Walker, S., & Read, S. (2011). Accessing vulnerable research populations: An experience with gatekeepers of ethical approval. International Journal of Palliative Nursing, 17(1), 14–18. https://doi.org/10.12968/ijpn.2011.17.1.14

Walton, C. (2016). Best and Brightest—Advancing Medical Research—2016 Medical Research Institute Sector Survey Report. Professional Scientists Australia. http://www.professionalsaustralia.org.au/mri/advocacy/campaigns/medical-researchers/

Walton, C. (2017). Stemming the Tide Addressing the Attrition of Women from the STEM Workforce. Professionals Australia. http://www.professionalsaustralia.org.au/professional-women/wp-content/uploads/sites/48/2014/03/Stemming-the-Tide-publication-email-version.pdf

Walton, C., Walker, K., & Porter, R. (2018). Professional Scientists Employment and Remuneration Report. Professionals Australia. http://www.professionalsaustralia.org.au/financial-edge/salary-survey-reports/scientists5/

Webster, F., Rice, K., Christian, J., Seemann, N., Baxter, N., Moulton, C. A., & Cil, T. (2016). The erasure of gender in academic surgery: A qualitative study. American Journal of Surgery, 212(4), 559–565. https://doi.org/10.1016/j.amjsurg.2016.06.006

Wellcome Trust. (2020). What researchers think about the culture they work in. Wellcome Trust. https://wellcome.org/reports/what-researchers-think-about-research-culture

White, K. (2001). Women in the Professoriate in Australia. 3(2), 14.

White, K. (2004). The Leaking Pipeline: Women Postgraduate and Early Career Researchers in Australia. Tertiary Education and Management, 10(3), 227–241.

White, K. (2014). Keeping Women in Science. Melbourne University Press.

White, K., & Burkinshaw, P. (2019). Women and Leadership in Higher Education: Special Issue Editorial. Social Sciences, 8(6). https://www.researchgate.net/publication/334154492_Women_and_Leadership_in_Higher_Education_Special_Issue_Editorial

Wiles, R. (2006). Researching researchers: Lessons for research ethics. Qualitative Research, 6(3), 283–299.

Winchester, H., & Browning, L. (2015). Gender equality in academia: A critical reflection. Journal of Higher Education Policy and Management, 37(3), 269–281. https://doi.org/10.1080/1360080X.2015.1034427

Winefield, A. H., Boyd, C., Saebel, J., & Pignata, S. (2008). Job stress in university staff: An Australian research study. Australian Academic Press.

Wisker, G., Robinson, G. D., & Leibowitz, B. (2019). The purpose and impact of postgraduate knowledge. Studies in Graduate and Postdoctoral Education, 10(3), 160–172. https://doi.org/10.1108/SGPE-05-2019-0054

Woolston, C. (2015). Uncertain Futures. Nature, 526, 597–600. https://doi.org/10.1038/nj7574-597a

Woolston, C. (2016). Reality Check. Nature, 537, 573–576.

Woolston, C. (2017). A love–hurt relationship. Nature, 550, 549.

Woolston, C. (2018a). Isolation and Alienation Force Female Researchers out of US Tech Jobs. http://blogs.nature.com/naturejobs/2018/02/21/isolation-and-alienation-force-female-researchers-out-of-us-tech-jobs/

Woolston, C. (2018b). Paths less travelled. Nature, 562, 611–614. https://doi.org/10.1038/d41586-018-07111-8

Woolston, C. (2018c). Satisfaction in science. Nature, 562, 611. https://doi.org/10.1038/d41586-018-07111-8

Woolston, C. (2019, January 24). Postdoctoral mentorship key to career success. Nature Careers. https://www.nature.com/articles/d41586-019-00262-2?sap-outbound-id=0CDF669699C1C4B024C20B5040044DEA1CDC4D86

Zaringhalam, M. (2016, September 20). Why ‘Alternative’ Careers in STEM Aren’t ‘Alternative’. The Chronicle of Higher Education.

https://chroniclevitae.com/news/1549-why-alternative-careers-in-stem-aren-t-alternative

Zusi, K. (2016). Life Sciences Salary Satisfaction Survey. The Scientist Magazine. https://www.the-scientist.com/?articles.view/articleNo/47311/title/2016-Life-Sciences-Salary-Survey/

Chapter 3|

Research Design, Methodology, Methods

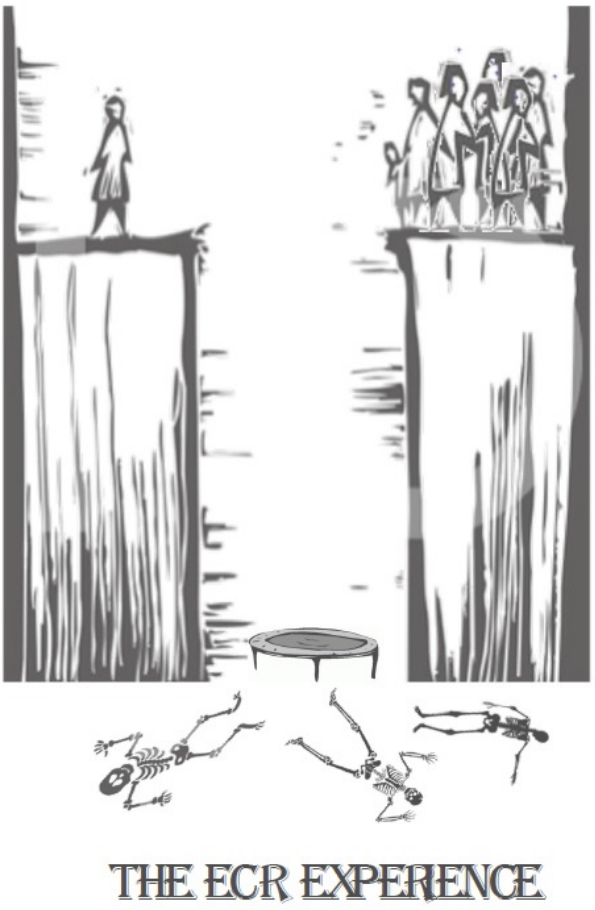


Image included with permission of Prof Don Newgreen

3.1 Introduction

Chapter 3 discusses research design, methodology and methods for this research project. It begins with the scope, then addresses matters relating to the ethics approval, the research question, the selection of the methodology, the theoretical framework and the conceptual framework. As this is a mixed methods project, as explained in Chapter 2, this chapter goes on to justify the selection of a mixed methods approach. The next section discusses the institutional approval process and subsequent recruitment of research participants and includes a summary of the demographic and employment characteristics of the participants. Following that I describe in detail the various methods utilised for the project, namely focus group discussion, on-line survey, semi-structured in-depth interviews and journaling and then describe the methods used for the quantitative and qualitative data analysis and data validation.

The section on institutional approval incorporates one of the two articles which I was invited to submit to Research Ethics Monthly, a peer reviewed blog managed by the Australasian Human Research Ethics Consultancy (AHRECS).

3.2 Scope

The focus of this work is on early-career researchers who are involved in research within all scientific disciplines at universities and research institutes in Australia and who are up to 10 years postdoctoral. This definition matches “early career” as defined by the National Health and Medical Research Council (NHMRC) and Global Young Academy (Friesenhahn & Beaudry, 2014; Geffers et al., 2017) and by another important survey of the STEMM workforce conducted in Australia (Bell & Yates, 2015).

Although the term early-career researcher (ECR) is widely used, its definition varies. This research uses a definition consistent with the NHMRC's "New Investigators" category (in use until 2018). Other researchers consider ECRs to include doctoral students together with researchers who completed their PhD within the past 10 years and do not hold a permanent position (Bell et al., 2016; Geffers, 2017; Handel & Knight, 2017). Sometimes an ECR is defined simply as "younger than 40" (Bos, Langer, & Flood, 2017). The Australian Early- and Mid-Career Researcher Forum (EMCR Forum) defines "emerging scientists" slightly more broadly, as researchers who are up to 15 years post-PhD (or other research higher degree), irrespective of their professional appointment. Internationally, the Global Young Academy (GYA) represents all scholars working in any research-based discipline, including the sciences, medicine, engineering, social sciences, the arts and humanities in the early years of their independent careers. The majority of the GYA's members are aged 30-40 and the typical period from completion of a PhD or similar degree is three to 10 years (Friesenhahn & Beaudry, 2014).

People employed in private enterprise/industry, not-for profit entities or in government funded organisations such as CSIRO or ANSTO were excluded from this project as their research environments are considered different; salaries and contracts are set up differently, and these types of institutions do not provide the same sort of training environment as a university or research institute.

I believe that the researchers who are the focus of this project should be considered to be part of "academia" and thus I refer to their workplace experiences compared to the experiences of other academics. It is typical for Australian academics to have responsibilities made up of 40% teaching, 40% research and 20% service. Only 30% of my respondents have a research and teaching work structure, however those who are full-time researchers are still a

sub-set of academia. Although they have a different work structure, they are either employed by a university or working in an independent research institute affiliated with a university. While they do not teach classes, supervision of higher degree by research students (HDRs) is part of their expected role. Like other academics, full-time researchers are measured by the university on successful student completions, and on the number and quality of their publications. They measure themselves by their grant success, by the number of publications, number of students supervised and number of collaborations. Those in the research-only workplace typically employ academic language, thinking and approaches to their work.

Clinician researchers, who are only a small portion of my respondents (5%), are another sub-set of academia. They typically have an affiliation to a university and to a hospital. They are likely to supervise HDRs if they have a formal part-time research position, and sometimes even if they do not. These clinicians will conduct their research with an academic purpose, and an intention of publication in an academic journal. Clinician researchers will often teach as well, usually, but not necessarily, teaching medical students from the affiliated university. In some specialties it has become essential to provide evidence of academic research success in order to progress in their careers. Clinician researchers are less likely than full-time researchers to rely on grant funding for their salaries, but they will be dependent on successful grant funding for their research costs.

3.3 Research Questions

As mentioned in Chapters 1 and 2, the research questions to address the topic were:

- What are the relationships between ECR job satisfaction or dissatisfaction and their likelihood of staying in science?

- What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?
- What are the motivations for ECRs leaving the sciences?
- What are the specific features of the experiences and environment of those ECRs who remain in the sciences?

3.4 Theoretical Framework

Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that makes the world visible (Denzin & Lincoln, 2005). How researchers carry out qualitative research depends upon a range of factors including their beliefs about the nature of the social world and what can be known about it (ontology), the nature of knowledge and how it can be acquired (epistemology), the purpose(s) and goals of the research, the characteristics of the research participants and the audience for the research as well as the position and environment of the researchers themselves (Ritchie & Lewis, 2003). Ontology is about the essence of the social world and the nature of reality and is often implicitly understood; therefore, it may be difficult to make explicit an ontological standpoint (Mason, 2017). One could take the approach of a positivist wherein reality is seen to be directly observable by a value-free researcher; of a postpositivist who assumes that reality exists, although it is imperfectly understood; a critical theorist who looks at historical reality crystallised over time, or a constructivist who approaches from relativism as opposed to realism (Guba & Lincoln, 1994; Howes, 2017).

In this project, I have taken a realist/postpositivist paradigm (Guba & Lincoln, 1994; Howes, 2017), thus declaring an understanding that reality is assumed to exist but can only be understood imperfectly. This reality must be subjected to the widest possible examination in

order to try to understand it as well as possible. I place myself as an expert researcher documenting reality from a centred position (Grbich, 2018).

Mason (2017) defines epistemology as considerations about whether something can be known about the (identified) ontological properties of the social world, how it can be known, and how such knowing can be shown. Denzin & Lincoln (2005) say that qualitative research involves an interpretive, naturalistic approach to the world, so that qualitative researchers study things in their natural settings, endeavouring to make sense of phenomena as viewed or expressed by the people they have impacted.

In approaching the qualitative data collected for this project, I have adopted the view of Denzin & Lincoln (2005) and taken an interpretivist epistemological stance. This view is shared by Ritchie & Lewis (2003) who state that that the researcher and the social world impact on each other. From the interpretivist viewpoint, facts and values are not distinct and findings are inevitably influenced by the researcher's perspective and values. I acknowledge that it is impossible for me, the researcher, to conduct objective, value-free research, particularly as I am, to an extent, an insider researcher (Greene, 2014; Unluer, 2012) but I must do my best to be so, aiming for (unattainable) perfection.

Turning to methodology, ‘‘the analysis of the principles or procedures of inquiry’’ (Merriam-Webster Dictionary, n.d.), I note that methodology is intertwined with the philosophical considerations of ontology and epistemology (Guba & Lincoln, 1994). Phenomenography is a qualitative research methodology which appeared in publications in the early 1980s (Marton, 1981, 1986). Phenomenographic research aims to explore the range of meanings within a sample group, as a group, not the range of meanings for each individual within the group (Åkerlind, 2005).

In exploring the views of seven focus group attendees, of eight interviewees and of numerous on-line survey respondents, as expressed in their open text answers, I have employed phenomenography to investigate the different ways in which study respondents have experienced their work environments with an aim of reporting on the experiences and viewpoints as representative of the whole group of ECRs in Australia. No one interview transcript or survey comment can be understood in isolation from the others (Åkerlind, 2005) but interpretation of them all together makes a whole.

Last, I have approached the project with a transformative purpose, aiming to ultimately promote social change. Trevors et al. (2012) describe transformative research as that which "transforms" or causes a major change in thought patterns concerning an area of scientific endeavour. Antunes (2009) noted a transformative approach is particularly suitable for connecting research with management consulting as it attempts to integrate action and reflection, personal and organizational realities, and theory and practice; it is expected this approach will apply in a similar manner to connect research with management practices in higher education.

3.5 Conceptual Framework

In this study I sought to measure factors contributing to the job satisfaction, or lack of satisfaction, of ECRs in the sciences. As there was no existing framework for researchers in academia, I sought to extend previous work by Rosser et al. (listed below) which modelled factors contributing to job satisfaction in academia at large. The initial conceptual framework was based on the framework for intention to leave created by Johnsrud & Rosser (2002) and further developed in later work on job satisfaction and intention to leave (Rosser, 2004), changes in job satisfaction over time (Rosser, 2005) and job satisfaction and productivity (Mamiseishvili & Rosser, 2011).

Johnsrud and Rosser (2002) proposed and tested a multilevel structural equation model on the quality of faculty worklife encompassing professional priorities and rewards, administrative relations and support, and the quality of benefits and services. The purpose of their model was to ascertain the impact of faculty worklife and morale on intent to leave and determine whether the impact is a function of individual or institutional perceptions. In later work, Rosser (2004) found that the perceptions held by faculty members of their worklife have a direct and powerful impact on their satisfaction, and subsequently on their intentions to leave.

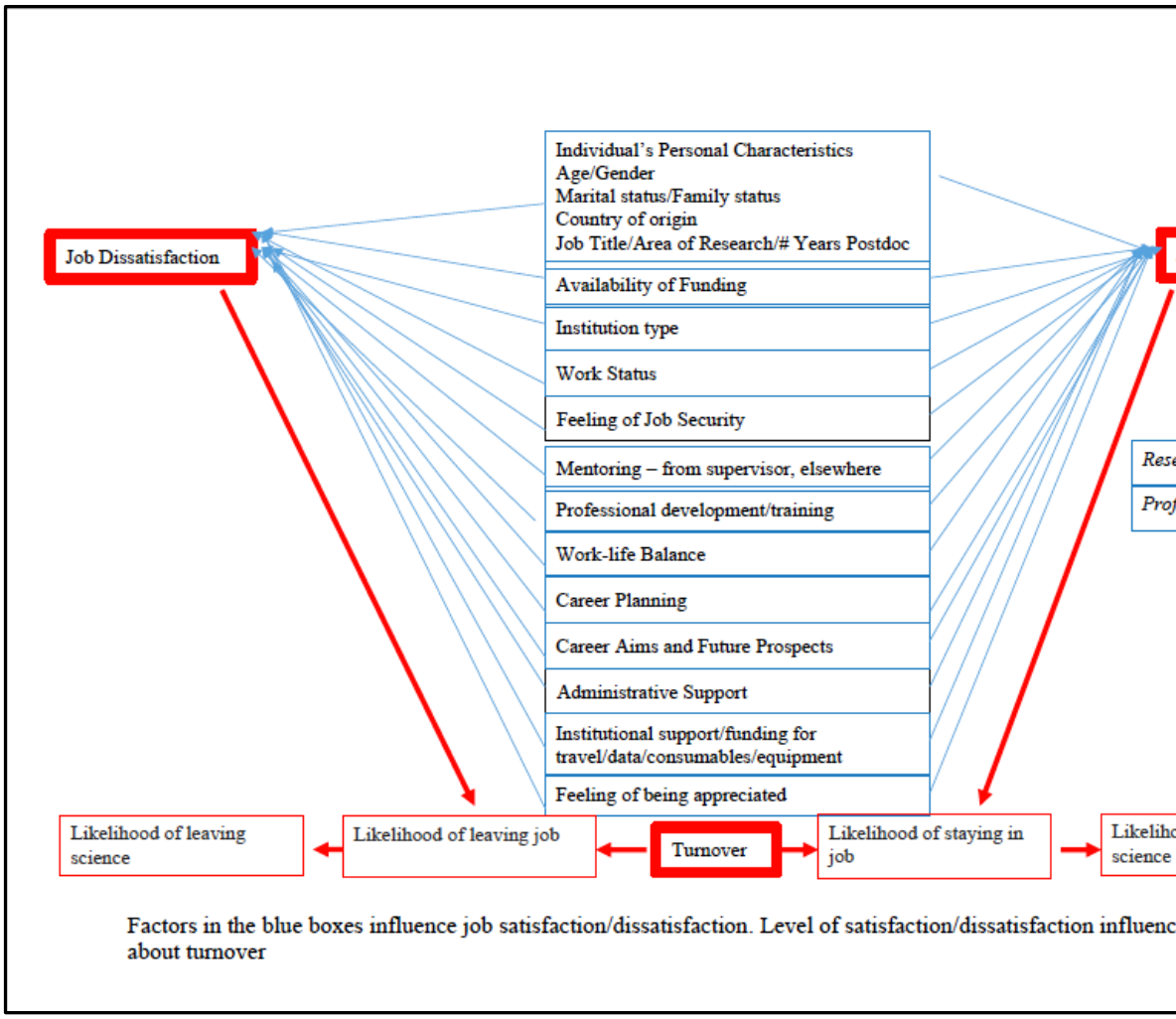
The framework for job satisfaction developed by Basak & Govender (2015) also contributed to the initial framework. Their framework was created from the factors affecting university academics' job satisfaction identified in the literature relating to their research question "What are the important factors that affect university academics' job satisfaction?" Having reviewed the literature about the job satisfaction of university academics, they concluded that regardless of which theory is followed, work itself, salary and related compensation, job security, administration and management, facilities, and working conditions were all important factors contributing to the job satisfaction of university academics. Factors with more personal impact including promotional opportunities, supervision, individual's personal characteristics, commitments and workload were also regarded as important factors.

The framework initially proposed for this project, shown in Figure 2, is thus a combination and development of the three different frameworks relating to job satisfaction and intent to leave put forward by Johnsrud & Rosser (2002), Rosser (2004) and Bazak & Govender (2015). It includes the elements identified by Basak and Govender (2015) and has more detailed elements for job satisfaction than that of Rosser (2004). The changes were

made to meet the needs of the research questions and of the specific scientific research environment within academia because the prior models were developed for academia as a whole.

Figure 2:

Initial Conceptual Framework for Factors which Influence Job Satisfaction and Turnover of Early-Ca



Factors in the blue boxes influence job satisfaction/dissatisfaction. Level of satisfaction/dissatisfaction influenc about turnover

This model addresses in further detail job security and availability of funding, institutional support, mentoring and number of years postdoctoral, all of which were later shown to be matters of importance to both interviewees and respondents to my on-line survey (this is discussed in Chapter 4). My initial conceptual model did not include some factors which relate to the research workplace and which emerged during data collection. These factors included the impact on the researchers of poor supervision, bullying and harassment and questionable research practices which has since been reported in Christian et al., (2021), or the importance of number of years since the individuals were awarded their higher degree, all of which are discussed in Chapter 4. The model was subsequently adjusted and an updated model reflecting these factors has been included in Chapter 4 (Section 4.4.2).

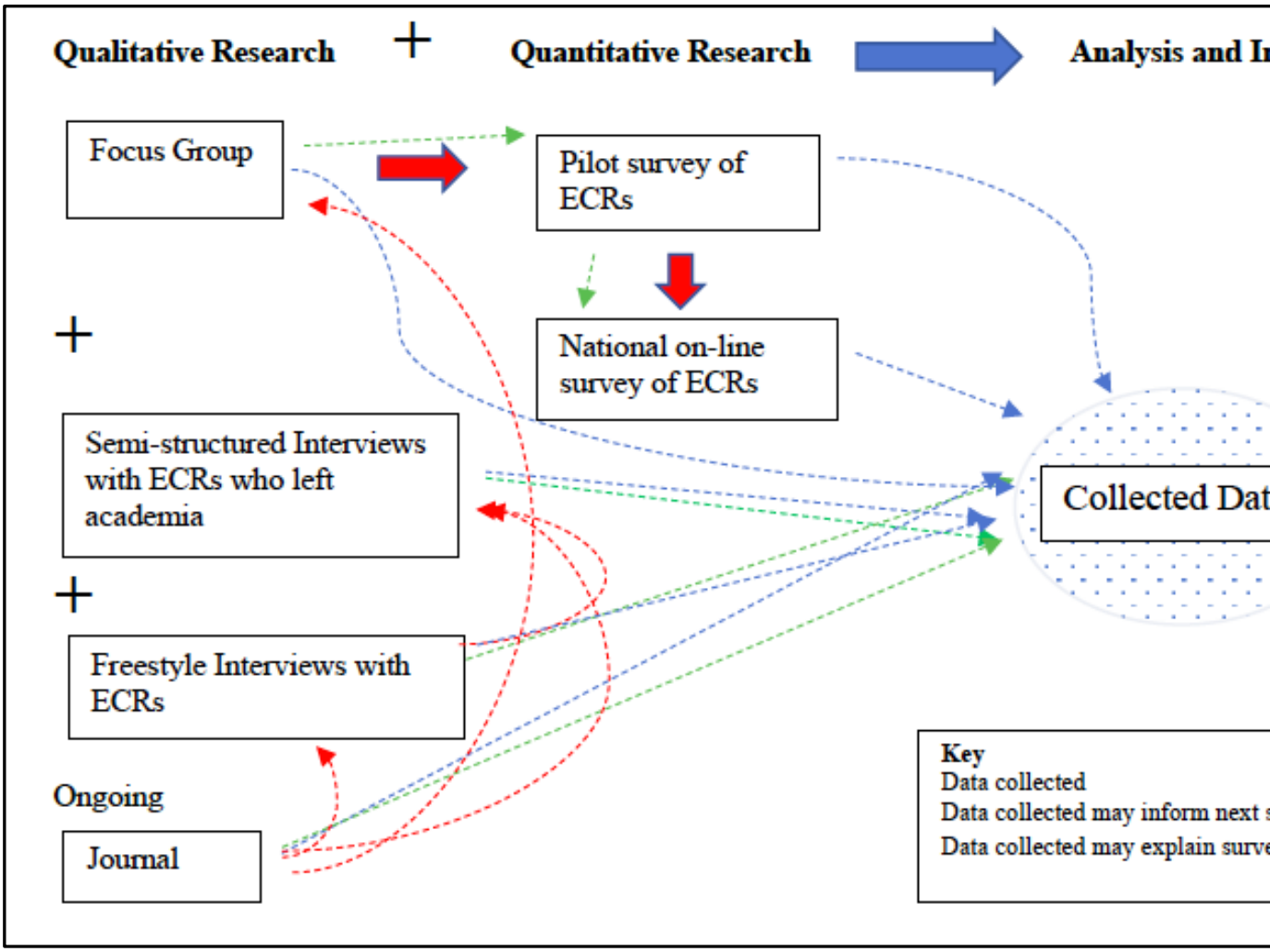
The approach of this project differs from that of Browning et al. (2016, 2017) who have also investigated problems experienced by ECRs in Australia. Where they examined the experiences of senior researchers and documented useful organisational strategies within universities, my research places STEMM ECRs at the centre of the study and explores their job satisfaction and its relationship to intention to stay in or leave the research and/or scientific environment.

3.6 Research Methods

A "mixed methods" approach, comprising collection and interpretation of both qualitative and quantitative data, was used for the research and is illustrated in Figure 3.

Figure 3:

Mixed Method Approach for the Project



The tools used for this project included:

- Quantitative and qualitative data from a large-scale on-line survey of ECRs (n=658)
- Additional qualitative data derived from
    - one focus group with seven participants
    - eight semi-structured interviews
    - reflective journaling
    - freestyle interviews (recorded in reflective journal)

Combined use of both the quantitative and qualitative data have provided a rich understanding of the reasons and motivations behind the responses of on-line survey participants. In this explanatory sequential design, the quantitative on-line survey data has been drawn together with the open-ended data gathered by the four qualitative methods for interpretation based on the combined strengths of both sets of data to understand the research problems (Creswell, 2015).

3.6.1 Justification for Mixed Methods Approach

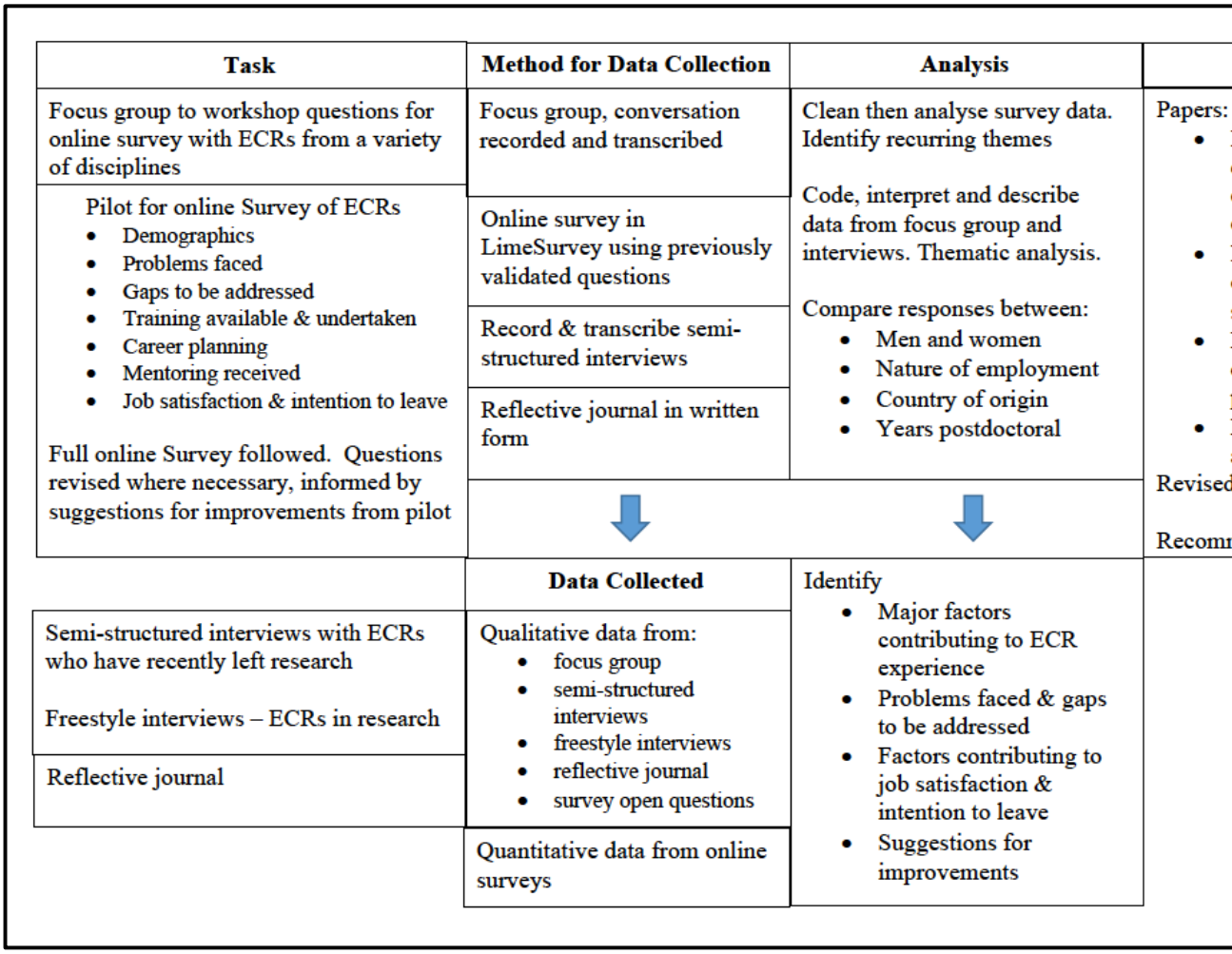
A mixed methods approach was selected because it permitted collection of data from a large number of people in a range of institutions and institution types across Australia (the on-line survey, the quantitative data), enriched by the more focused, deeper data collected in the qualitative research (focus group, open-text on-line survey responses, interviews and reflective journaling). Without the quantitative survey it would not have been possible to cover views of ECRs working in the range of disciplines and institute types represented in STEMM in Australia; without the qualitative elements it would be difficult to truly

understand the reasons behind the factors which influence job satisfaction or dissatisfaction and consequent intention to leave. Job satisfaction is, by definition, very subjective for the person, and subjective information is difficult to collect in a large-scale survey. The focus group informed the on-line survey, the survey informed the interviews and throughout the project the journal provided opportunities for reflection and recording observations about the ECR workplace. Brought together, these methods have enriched one another and together provide a descriptive picture of the important factors that contribute to the ECR experience.

The research methods are illustrated in Figure 4 and described in detail in the subsections which follow.

Figure 4

Detailed Research Methods for the Project



3.7 Ethics Approvals

Ethics approval for this project was granted by Federation University Australia's Human Research Ethics Committee (Approval 18-139) on December 4, 2018. An amendment was granted for minor changes to the questionnaire on March 1, 2019 and two further amendments for data storage were approved in June and August 2020. All documentation relating to the ethics approval process can be found in Appendix A.

3.7.1 Protection of Privacy and Confidentiality

As personal information was collected in the surveys, responses were anonymous. A parallel survey permitted respondents to optionally provide email addresses if they wished to receive results or make themselves available for follow up interviews. It was not possible to relate this second survey to the main survey, so survey data remained anonymous.

The focus group and interviews were recorded, with recordings deleted once transcribed. In all modes of data collection participants were assured that all responses would be de-identified. Survey participants were advised that results would be presented at a group level; interview and focus group participants approved the use of pseudonyms for both their names and their places of employment. Consequently, respondents who took part in in-depth interviews and the focus group have been de-identified in the transcripts, as have their places of work. Survey respondents have been allocated numbers as a pseudonym, and any text from open-text questions which could lead to their identification has been de-identified or removed.

Although I gave an undertaking to report only group data, as there was at least one survey question that could possibly lead to the identification of respondents, this question (Q3 What is the name of your institution?) was made optional.

3.7.3 Ethics Reporting

Annual reports were submitted and accepted in 2019; the final report will be submitted in November 2020.

3.7.4 Adverse Events

There were no adverse events during the time of data collection.

3.7.5 Further Use of Data

The survey collected a wide range of data about the ECRs and the ECR experience. It was agreed that it was necessary to take this broad approach in order to be certain to fully understand the experiences of ECRs in many and varied environments. It has not been possible to analyse all the data collected in detail, question by question, in the time available for this PhD project, however approval has been sought in the ethics application and in participant documentation to permit these data to be made available for further research. Approval has subsequently been received to make the project data open source.

Some survey data have been made available on Federation.Figshare.com (https://federation.figshare.com/projects/Challenges_Faced_by_Early-Career_Researchers_in_the_Sciences_in_Australia_and_the_Consequent_Effect_of_those_Challenges_on_their_Careers_a_Mixed_Methods_Project/90317); as mentioned above, any data which could lead to identification of the respondent (such as reference to an institution) has been anonymized or removed.

3.8 Data Collection

3.8.1 Recruitment of Research Participants

I received approval to recruit participants to the proposed focus group, on-line survey and interviews by means which had been clearly defined in the ethics approval process. The approved invitations and advertisements are included in Appendix A. Before I could invite anyone to take part in the project, I first had to seek approval from their employing institution in a process described below.

3.8.1.1 The Process of Gaining Institutional Approvals

The Human Resources Ethics Committee (HREC) approved my proposed research project on the first application with a condition: that prior to extending an invitation to any staff member, at any institution, to participate in the research, I should "submit the external organisation's approval/permission letters" to the HREC.

In order to obtain as broad a sample of on-line survey respondents as possible, I identified the 37 Australian universities known or expected to conduct research in scientific disciplines and prepared to obtain approval from these universities to extend an invitation to their staff to participate in the project.

I first had to work out how I should reach out to these institutions in order to seek "gatekeeper" approval (Horan & Israel, 2016; Walker & Read, 2011). I decided to send individually addressed letters, on Federation University letterhead, to each university, referring to the nature of the project, the target population and the conditional approval from the HREC. I sent these letters via email with a covering note. I also approached eight

independent medical research institutes, where I had had previous contact with senior staff, in this manner.

It was, of course, necessary to identify the "gatekeeper", the appropriate person at each university from whom to seek permission. Universities are generally large and multi-faceted organisations; no advice was provided by the HREC about who should provide the required approval. Although I made efforts to find the appropriate procedures via university websites, I was unable to find guidance for seeking permission to either contact or survey staff members on any of the university websites. I decided to make two types of approaches:

- To obtain a single approval for the university via the Deputy Vice-Chancellor (Research) or the Deputy Vice-Chancellor (Academic), or, where this position existed, Dean of Graduate Studies
- To obtain multiple approvals from Deans or equivalent of all relevant schools or faculties within a single university.

Although I hoped Deans of Graduate Studies would be responsive to a request from a PhD candidate, I expected Deputy Vice Chancellors would have more important priorities than granting permission for conduct of a PhD project for another university. While it seemed likely that approaching the Deans of faculties and schools might lead to the required permission, I recognised that this approach would require multiple approvals from each organisation and there was a risk that lack of understanding of the structure of each individual university could cause me to overlook some STEMM disciplines in individual universities.

My knowledge of general university structure allowed me to make an informed choice for the appropriate people at each institution, and I sent the email requests accordingly. Some responded; if there was no response, I sent a second request to the same person. If the second

request was unsuccessful, I identified another recipient and tried again. I sometimes needed to try numerous avenues before receiving any reply. As time passed, it became clear that it was unlikely that I would receive any response from some universities and there was little purpose in pursuing them.

3.8.1.2 Was the Need for Institutional Approval Justified?

It is my view that the HREC's requirement for institutional approval prior to recruiting individuals to the project was a misinterpretation of the requirements outlined in the National Statement on Ethics in Human Research (National Health and Medical Research Council, 2018). This matter is discussed in the article Christian et al. (2019) included at Section 3.8.2.

3.8.1.3 Position of Christian et al. (2019) in the Thesis

This article was prepared as part of my PhD research. It was published at the invitation of the editors of Research Ethics Monthly, a peer-reviewed blog managed by Australasian Human Research Ethics Consultancy Services (AHRECS) which features articles on human research ethics and research integrity matters of relevance to researchers. This article is included in the thesis as it contributes to understanding of the methods employed for my research. It is presented as it was presented in the blog.

3.8.2 Article: The need to seek institutional approval to survey staff – was this a misunderstanding of the purpose of Guideline 2.2.13 in the National Statement on Ethical Conduct in Human Research?

We have conducted a research project investigating the factors contributing to the satisfaction – or dissatisfaction – of early-career researchers (ECRs) from across Australia working in the sciences. A requirement of our ethics approval was a need to provide evidence

from every university and research institute of permission to approach their staff to invite their participation in our research.

This requirement was a consequence of answering 'yes' to the following question:

If your research involves participants from other organisations (e.g. educational institutions, companies, agencies, collectives), you may need to obtain authorised approval before approaching participants, eg: Department of Education and Training, School Principals, School Councils (for research involving Government schools); Catholic Education Office (Catholic schools); School Boards (Independent schools); Senior Officers (Commercial or Government entities); Elders (Aboriginal communities); or Representative bodies (Collectives). Copies of approval letters must be attached to this application or, if pending at the time of submission, forwarded to HREC when available. Some authorities may decline to provide permission letters until ethics approval has been granted. In such cases, you should submit your application to the HREC for provisional approval pending receipt of the documentation.

Does research involve or impact on participants from external agencies or organisations? Yes No

Our project entailed collection of data from researchers, typically from other institutions, no more than ten years past the award of their PhD who could be participants in a focus group, one-on-one in-depth interviews or in a national on-line survey. The precise method for extending invitations to participants for each of these activities (which included email invitations, social media posts, and advertising by relevant bodies) was specified in the ethics application and approved by our Human Research Ethics Committee (HREC). In most cases email approaches were to be made by third parties, for example distribution of a

forwarded email; otherwise email contact was limited to those people whose contact details were known or publicly available.

The eligible population was adult, clearly defined and without special risks; individuals were able to offer informed consent as defined in the overarching principle for consent in the National Statement defined in Section 2.2.1:

The guiding principle for researchers is that a person's decision to participate in research is to be voluntary, and based on sufficient information and adequate understanding of both the proposed research and the implications of participation in it.

An attempt to meet the requirement to seek approval for people to be invited to take part in the survey from the prospective 37 universities and many independent research institutes was extremely arduous and a significant barrier to recruitment. We question whether seeking this approval added ethical value, and indeed, whether it may have been required because of a misunderstanding of the purpose of the National Statement, in particular of Section 2.2.13:

Within some communities, decisions about participation in research may involve not only individuals but also properly interested parties such as formally constituted bodies, institutions, families or community elders. Researchers need to engage with all properly interested parties in planning the research.

Section 2.2.13 of the National Statement is placed in the section 'Where others need to be involved in participation decisions' and appears directly after a section relating to potential participants who lack the capacity to consent. This requirement appears on the documentation of some other Australian HRECs, (including Australian Catholic University, University of Melbourne, Menzies Research Institute). However, we believe this section of the National

Statement is intended to apply to research conducted within organisations and communities that have a duty of care towards people – or groups of people – who are at risk, such as Aboriginal and Torres Strait Islander peoples, school students or adults with special needs.

Alternatively, it could be construed the request to obtain approval is a misunderstanding of the first part of 3.1.16 and that HRECs take the view that the institutions, in their capacity as employers, have a duty of care as 'gatekeepers' for their employees.

Researchers and reviewers should consider the degree to which potential participant populations might be over-researched or may require special consideration or protection and the degree to which the flow of benefits to that population (or to individual participants) justify the burdens.

The latter part of this section suggests that individuals within the ECR population that we were attempting to sample could have been permitted to make up their own minds about participation, as they do not fall into the type of special category suggested.

Equally, people should not be denied the opportunity to exercise self-determination or obtain the potential benefits of research solely because they are a member of a population that might be over-researched or may require special consideration or protection, such as Aboriginal and Torres Strait Islander peoples.

The literature about the work-life of ECRs in STEMM disciplines in Australia does not show evidence of an over-researched ECR population or a group which merits special consideration. We are aware of only two national surveys of Australian ECRs in STEMM in recent years (Hardy, Carter, & Bowden, 2016, Meacham, 2016).

If any university staff member received an invitation to participate from an external researcher, whether directly or forwarded from an internal address, it is unlikely they would

have wondered if either the researcher, or they, needed permission from the organization. Instead, they would make an individual decision on participation or otherwise, and act accordingly.

We used several recruitment strategies. Since all the potential participants worked at universities and research institutes, a direct approach to these entities provided the logical and, indeed, preferred avenue. Organisations and associations whose members were likely to represent the target audience were also approached; these 'umbrella' groups were very supportive of requests for assistance with recruitment of participants and, more generally of the research. They extended an invitation to their members on behalf of the project team via broadcast email and social media. Another HREC-approved method of recruitment was via social media. Social media, which has no boundaries, proved itself to be a successful avenue for recruitment and due to its very nature and culture of sharing brought in responses from prospective participants based at many universities from which we had received no response to our initial request for approval to recruit their staff. Such responses did not violate ethics requirements, again bringing into question the merits of seeking institutional approval.

We did not interpret the requirement to obtain approval as being necessary for the 'umbrella' organisations as they do not have the same responsibility for, or duty of care to, the ECRs. This highlights another anomaly in the interpretation of the guidelines: what constitutes 'an organisation' from which approval might be required? So saying, we interpreted the ready agreement of these organisations to share the invitation, whether by distributing the link by email or by promoting it on social media, as implicit approval.

We recommend that HRECs amend their forms to permit researchers to offer further explanation about the nature of the people being recruited and their capacity to freely make a consent decision so that the Committee members can make appropriate decisions about the

need for institutional approvals. We argue that these approvals should only be required when the research participants need a particular level of protection.

3.8.3 Recruitment for the Survey

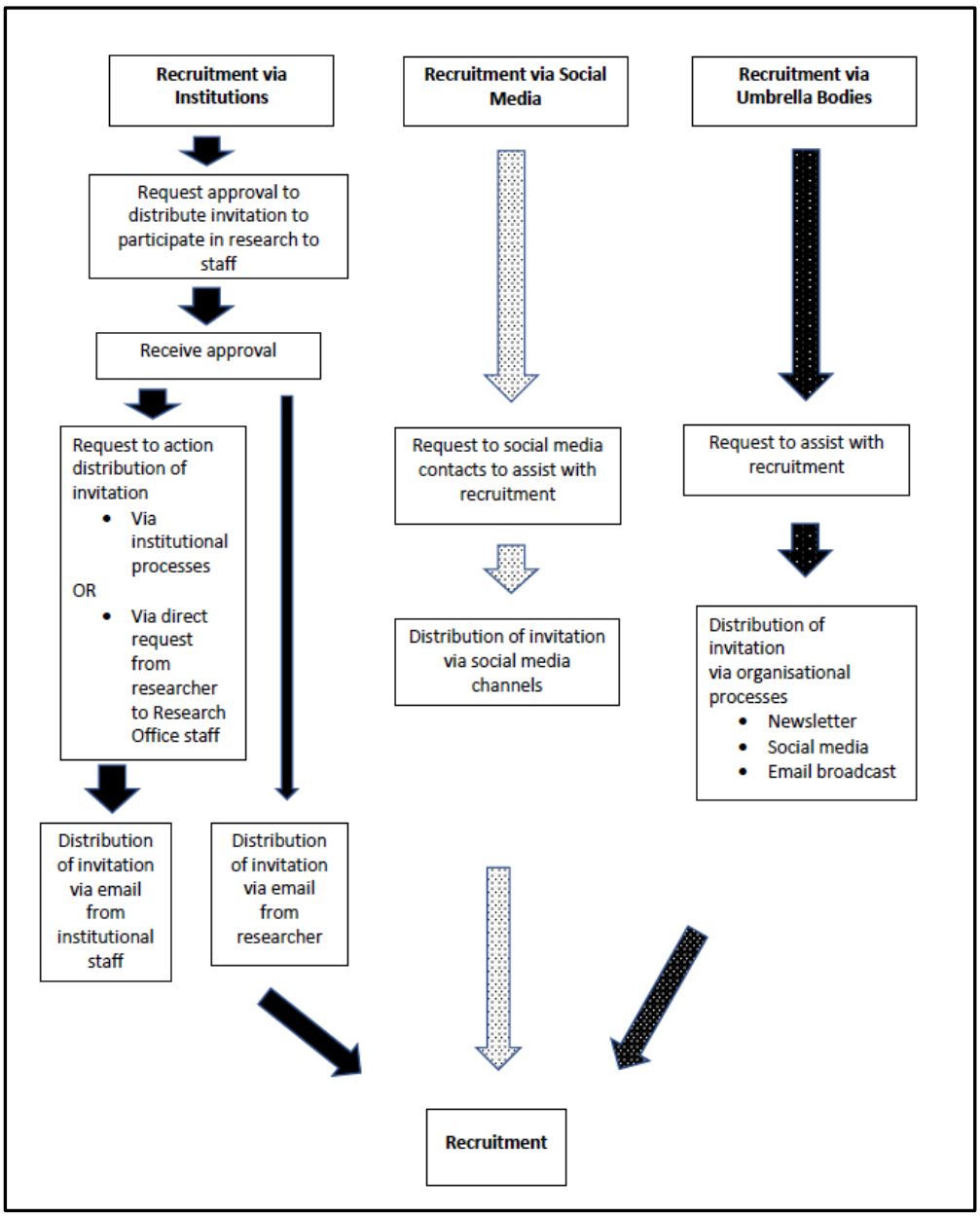
I aimed to recruit as many survey respondents as possible within approximately three months. As mentioned in Scope (Section 3.2) eligibility criteria included holding a PhD or equivalent, awarded no more than 10 years prior and employment in an Australian university or independent research institute in a STEMM discipline.

Invitations to participate in the on-line survey were distributed via email, using standard approved text, or via a link on a social media platform, Twitter, LinkedIn and Facebook (see Appendix A). The link took potential respondents to the first page of the survey, in Federation University Australia's LimeSurvey application. Participant eligibility was determined by the first three questions in the survey; participation was terminated for those whose answers indicated that they were ineligible.

The processes leading to recruitment, via universities, research institutes and organisations representing the target participants, and via social media are outlined in Figure 5 and discussed in further detail below.

Figure 5:

Processes Leading to Recruitment



3.8.3.1 Steps for Distribution of the On-line Survey Invitation

Where I had received approval, distribution of the on-line survey invitation within the organisation was usually relatively simple, although there were numerous different processes. Generally, the "approver" either delegated the task directly to a staff member or provided an

instruction about who in their organisation could help to distribute the invitation. Sometimes permission was given, but without any further direction; in these cases, the best next step was usually to ask for assistance from the Grants or Research Office.

In order to extend the reach of the study, and to ensure inclusion of people from independent research institutes, I distributed the invitation to take part in the on-line survey via social media. I also approached organisations which are "umbrella bodies" representing scientists from institutions across Australia and asked them to assist with distribution of the invitation link. As described in Christian et al. (2019) (see Section 3.8.2) I did not interpret the requirement to obtain approval as necessary for these "umbrella" organisations as they do not have the same responsibility for, or duty of care to, the ECRs. At the same time, I interpreted the ready agreement of these organisations to share the invitation, whether by distributing the link by email or by promoting it on social media, as implicit approval.

Nine scientific "umbrella" bodies gave prompt approval and followed up with distribution by a variety of actions including placement of the invitation in their regular newsletter(s), inclusion in an email to all members or promotion in social media feeds.

After recruitment had been underway for two months, I noted women were over-represented, and there was an under-representation of ECRs from core sciences (chemistry, physics and mathematics) compared with medical, health and biological sciences. I employed a number of strategies to increase participation from men, and from the members of core sciences, including placing requests on social media for more men and more core scientists, approaching the Australian Council of Deans of Science for assistance and asking for help from some small representative bodies which represent specific disciplines such as the Chemistry Institute and Astronomical Society.

The data collection process from seeking institutional approval from the gatekeepers to the close of the on-line survey took seven months. The project received conditional ethics approval on December 8, 2018 and I distributed initial request letters to the institutions during December. I sent follow up request letters during January and February 2019. I acknowledge that the approval process was slowed by starting it during the Australian university shutdown period. I sought approval in February for amended questions for the on-line survey following the focus group and pilot survey and received it promptly on March 1, 2019. The on-line survey was finalised and opened on March 1, 2019. I distributed invitation emails and social media messaging from March 3 until May. I continued the process of seeking approval from non-responding universities, a cause of delay to data collection throughout the project, until mid-May, and the on-line survey closed on June 12, 2019.

3.8.3.2 Outcomes of Survey Recruitment

I received approval from 23 of 37 universities (62%) and eight of a possible 42 independent medical research institutes (19%, although 100% of those approached directly for approvals) and most of these gave me active assistance. There was no response at all from 10 universities; four others, following some interaction, failed to give approval (as opposed to denying approval). No institution refused approval.

Table 3:

Responses for Requests for Approval from Specific Positions at Universities and Independent Research Institutes

University position approached	**# Approvals Received**	**Personal Contact**	**# No response**
Deputy Vice Chancellor (Research) or Deputy Vice Chancellor (Research and Innovation)	11	1	14
Deputy Vice Chancellor (Academic)	2	1	0
Pro Vice Chancellor (Research)	2	0	0
Dean of Faculty (Science, Health, Medicine etc)	10	3	9
Executive Deans (or equivalent general research)	1	0	2
Dean of Graduate Studies (or equivalent general)	0	0	2
Research institute position approached			
Director or CEO	8	8	0

*Approval from both a Deputy Vice Chancellor and a Dean received at one university; approvals from two Deans at two universities; total 26 approvals for 23 universities

Table 3 provides details of the responses to requests for approval from people in specific positions at universities and independent research institutes. Some people at the universities were a little surprised by the request:

> I'm a little puzzled about why you need permission to contact staff. Is this normal? I'm sorry that I don't have the authority to grant permission like this. So if it is an absolute requirement you'll need to get the Dean's permission.
> [Associate Dean, Faculty of Science acting in lieu of absent Dean]

Although I mentioned having received ethics approval in the request letter, the approval itself was not included. Some universities requested a copy of the ethics approval and/or of the on-line survey questions. Some were keen to have access to the data collected about their staff at the end of the project.

> happy to support this on receipt of a copy of the ethics approval letter and a guarantee that we will get a copy of any reports. Will the University data be de-identified and will we be able to access [our institution's] (de-identified) data so that we may do our own analyses? [DVC (Research and Innovation]

Two universities, University of Adelaide and Curtin University, had well defined special survey approval processes. Although these processes were not initially evident to the outsider, once my request reached the appropriate staff member through internal channels there was a familiar protocol for them to follow.

University of Adelaide advised "Learning & Quality Support (LQS) in the Division of Academic and Student Engagement can provide you with the University approval necessary to survey University of Adelaide staff and students". The application was passed to LQS by the University of Adelaide Ethics office.

Curtin University has the "Curtin Survey Approvals" process which is managed by the Office of Strategy and Planning. Curtin Survey Approvals asked me to complete an application form and provide a copy of the existing ethics approval. They also required me to nominate a "researcher partner"; I provided a personal contact from the Research Office for this purpose.

These approval processes described above appear to have been designed for internal staff for research within the university. Although the existence of these application systems was not apparent to me on the university website, it did permit the staff who received my request to follow a defined path which resulted in a clear (and positive) outcome after only a short time.

The processes for arranging approval required a different approach for almost every university and varied from streamlined to highly convoluted; they were sometimes different even from one faculty to another. At one university, one faculty gave approval and willingly distributed the email after a personal contact helped me find the right person to ask. By contrast, an Associate Dean in a second faculty gave me approval in principle but asked me to refer the request to that university's ethics office for checking. Having gained this approval, I was directed to IT. After this, my request went on to HR, and, simultaneously, the research manager for the Faculty but there was no further progress. I sent 15 emails in total to this university without ever receiving approval, apparently because there was no one who understood what internal process should be followed.

Table 4:

Time Taken for Institutions to Respond to the Request

Time Taken to Respond	# Approvals
0-7 days	10
8-14 days	5
15-50 days	2
51-100 days	8
101-160 days	6

Table 4 shows some approvals came promptly, often with an instruction to a staff member to facilitate the request or a helpful direction to me about who to contact. Others did not reply. Sixteen institutions approved after only one request; at the other extreme I did not receive approval at one university until there had been contact with 10 people over a period of 145 days.

Responses to my requests to the nine umbrella bodies (EMCR Forum, Australian Society for Medical Research (ASMR), Research Australia, Professional Scientists Australia,

Science and Technology Australia, SAGE, Australia Association of Medical Research Institutes, Australian Council of Deans of Science, Franklin Women) were much more straightforward. These organisations all agreed to broadcast an invitation for their members to participate in the on-line survey through either newsletters, websites or social media.

I received further assistance from numerous individuals who distributed the email invitation within their networks or via social media. I did not consider targeted recruitment of people who I did not know as it was simply too difficult and time-consuming to identify people who met my criteria and contact them individually.

3.8.3.3 Impact of the Need for Gatekeeper Approval

The gatekeepers had considerable influence on the project recruitment. This approvals process showed there were (at least) five different "types" of gatekeeper:

- The person who provided immediate approval and facilitated the process
- The person who provided immediate approval and made suggestions for next steps to be carried out by others
- The person who re-directed the request to a higher or different authority
- The person who did not know if they had authority to approve
- The non-respondent

I received responses from 658 eligible participants from at least 31 universities and 17 research institutes; as the question identifying the name of the institution was optional, it is not possible to be exact. Of the 381 respondents who identified their institution (58% of total), 286 (78% of "identifiers") were from 29 institutions from which I received approval and 84

(22%) from 29 institutions from which I did not receive approval. There were no identified responses from two of the institutions which gave approval.

The fact that over three quarters of participants who identified their institution came from "approved" institutions clearly indicates the negative affect on recruitment imposed by the need for gatekeeper approval. Had I been able to recruit directly through all institutions (for example, by enlisting the help of the research office by making a direct request, as had been my intention) rather than relying on social media and third-party organisations it could be expected that recruitment numbers could have been much higher. This recruitment method would have placed only a minimal burden on research office staff. There was no need for institutional staff to select potential participants other than choosing to send the invitation to people in science disciplines as the on-line survey questions determined eligibility.

It could also be argued there was potential for the introduction of sample bias as I readily gained permission from organisations where I was known.

Table 5:

Percentage of Workforce by Discipline

FoR Code	Discipline	% On-line Survey Respondents	% Australian Academic STEMM Workforce*
01	Mathematical Sciences	2.8	3.8
02	Physical Sciences	8.1	4.3
03	Chemical Sciences	5.7	4.7
04	Earth Sciences	3.0	3.5
05	Environmental Sciences	4.0	3.2
06	Biological Sciences	20.9	12.6
07	Agricultural and Veterinary Sciences	1.4	4.5
08	Information and Computing Sciences	2.2	6.9
09	Engineering	3.6	15.4

10	Technology	0.8	2.1
11	Medical and Health Sciences	47.5	38.9

*Source: State of Australian University Research 2018–19: Volume 1 ERA National Report

With regard to potential bias, it was pleasing to note that although I am unable to accurately determine representativeness by institution, the sample is representative by discipline as demonstrated in Table 5. The differences between my sample and the target population are not statistically significant (chi square = 16.344, df = 9, p = 0.06).

It is not possible to know the response rate to invitations received as distribution of those invitations was not within my control as a consequence of the invitations being distributed by third parties.

3.8.3.4 Demographics of the Respondents

Although strictly speaking these are results and not methods, the demographic and employment characteristics of the on-line survey participants are presented in this chapter due to the structure of this thesis. These demographic and employment characteristics are represented in Tables 6 and 7.

Table 6:

Demographic Characteristics of On-line Survey Respondents

Question	Number	Percentage
Question 2 What is the number of years since completion of your highest degree		
0-1	133	16.0
2-4	315	37.8
5-7	211	25.3
8-10	115	13.8
> 10 years (subsequently eliminated)	59	7.1
Total	833	100
Question 4 What is your Gender?		
Women	430	65.8
Men	223	34.2
Prefer not to say	5	
Total	658	100.0
Question 5 What is your Age?		
25–30	109	16.5
31–35	282	42.7
36–40	171	25.9
41–45	42	6.4
Over 45	56	8.5
Total	660	100
Question 6 Where were you Born?		
Australia	330	50.2
England	39	5.9
New Zealand	8	1.2
India	26	4.0
Italy	4	0.6
Vietnam	4	0.6
Philippines	3	0.5
China	18	2.7
Malaysia	11	1.7
Brazil	8	1.2
Other	207	31.5
Total	658	100.0

Demographic characteristics include number of years postdoctoral, age, gender, country of birth; employment characteristics include nature of employment (research, research and teaching etc.) manner of employment (full-time/part-time), and contract length for those on fixed-term contracts. It can be seen women were over-represented in the cohort, (65%)

however the division by gender is very similar to that for ECR participants for Bell & Yates (2015) (66% women) and (Hardy et al., 2016) (62% women) and this was not unexpected.

Table 7:

Employment Characteristics of On-line Survey Respondents

Question	Number	Percentage
Question 3 What is the Nature of Your Employment		
Teaching only	20	3.1
Research Only	399	62.5
Research and Teaching	190	29.8
Clinician Researcher	29	4.5
Total	638	100
Question 23: In which manner are you employed?		
Full time continuing	93	15.5
Part time continuing	14	2.3
Full time fixed term contract	386	64.2
Part time fixed term contract	83	13.8
Contractor / self employed	4	0.7
Other (please specify)	21	3.5
Total	601	100.0
Question 24: If you are on a fixed term contract, what is the total length of your [fixed-term] contract?		
Less than 1 year	81	16.7
1 to 3 years	315	64.8
More than 3 years	90	18.5
Total	486	100.0

The majority of on-line survey respondents are in research only positions and are typically full time and on a contract of 1-3 years' duration. A little over half are Australian born and nearly three-quarters are 30-40 years old.

3.8.3.5 Consideration of the Benefits and Risks of being an Insider

I note I may have introduced inadvertent "insider" bias into this study. While my relative success in obtaining approvals to conduct the research within the 62% of universities was substantially assisted by my insider knowledge, I may also have introduced insider bias by receiving the welcome assistance provided by the "umbrella bodies" with which I have ongoing connections, and which readily agreed to promote my study. The over-representation (though not statistically significant) of people from my fields of health and medical sciences could be evidence of this effect. This help from the Australian Association of Medical Research Institutes and ASMR, in particular, allowed me to attract 45 people who identified themselves as being from medical research institutes (12% of the respondents who named their institution); these may have otherwise been difficult to reach. This possibility for bias to health and medical research will have been counterbalanced by the support of EMCR Forum, of which I am a member, as their members are drawn from all STEMM disciplines and by the efforts of the Australian Council of Deans of Science and some small discipline-specific scientific associations. I received significant support from my connections on social media and expect that much of this assistance was because I am well-known within the community. The reach of social media as employed in this project was very powerful and very effective. I recommend that other researchers consider extension of their recruitment reach by following this approach wherever appropriate as social media, in particular Twitter and LinkedIn, are increasingly being used as a communication tool by STEMM researchers. I found the use of hashtags (including science, STEM, STEMM, Australia, ECR, EMCR, research, researcher, EMCRchat, PhDchat) beneficial.

3.8.4 Focus Group Discussion

I held a focus group discussion on January 30, 2019 with seven ECRs drawn from five disciplines and four institutions based in Sydney (for ease of access). These ECRs were invited by email, using text approved by the HREC (included in Appendix A) and all provided informed consent. The focus group discussion was recorded and subsequently transcribed; names have been changed to pseudonyms and institutions de-identified to ensure anonymity.

Table 8:

Focus Group Participants

Pseudonym	Institution Pseudonym	Discipline
Valentina	University A	biomedical research
Sophie	University A	pharmacology
Hilary	University B	pharmacology
Cassandra	University B	coastal geography
Angela	University C	mathematics
Josie	University C	non-verbal linguistics
Nick	Institute A	biomedical research

I invited the participants to discuss the proposed questionnaire. They had been asked to check the on-line survey questions were clear and to ensure all factors they believed contributed to job satisfaction were covered, and that no area of concern with respect to the academic worklife of ECRs had been omitted. This focus group discussion provided very good background information for the life of current ECRs and, in fact, identified the need for the inclusion of questions relating to bullying and harassment, chronic health conditions and caring responsibilities for people other than children. The discussion also provided me with insights into why they stay in their jobs in spite of difficult conditions.

3.8.5 Pilot On-line Survey and National On-line Survey of ECRs

As mentioned earlier, quantitative data for this project was collected in a nationwide on-line survey open to ECRs in Australian universities and research institutions and covered a number of broad topics including demographics, family situation, work status, job satisfaction and work challenges, mentoring, supervision and training. The survey was conducted online using LimeSurvey (v2.01). Eligibility to participate was determined by the initial questions in the survey which checked respondents had a PhD or equivalent, were up to 10 years postdoctoral and worked in a university or research institute.

A pilot on-line survey (n=22) permitted me to test for understanding and clarity and to check for technical difficulties. As for the focus group, participants were invited by email, using text approved by the HREC (see Appendix A). Twenty-two participants were recruited from several universities in different states via my personal contacts and via members of the supervisory team. I made an effort to include participants for whom English was not the first language. The pilot on-line survey was open from February 14 to February 28, 2019.

The pilot survey participants provided useful feedback on the structure and clarity of some questions and I made alterations to some questions which were subsequently approved by the HREC, in an amendment to the initial approval, on March 1, 2019.

The national on-line survey ran from March 5 to June 14, 2019. A total of 891 respondents started the national survey; of these 233 respondents gave answers to one of the first three questions (used to determine eligibility) which resulted in the survey being automatically terminated for them. These respondents either did not have a PhD or equivalent, were more than 10 years postdoctoral or did not work in a university or research institute. There were 658 respondents who fulfilled the eligibility criteria for the national survey and the pilot survey combined and completed at least part of the survey; 454 of the 658

respondents (70%) reached the end of the survey which took approximately 20 minutes to complete.

The parallel survey was completed by 151 respondents who provided a contact email offering to either assist in further research or receive survey results.

3.8.5.1 Structure of Questionnaire

The questionnaire for the on-line survey included 75 questions and was developed by first compiling questions, often used in a broader or international context, from research literature. To date, there have been a number of surveys of ECRs conducted internationally and in Australia which have been successfully used to identify the characteristics of the research environment and the experiences of the researchers. While none of the previous surveys has a range of questions suitable to address all this project's research questions, they were explored to identify previously tested questions appropriate for this research. As mentioned in Chapter 2, questions from the biennial Nature surveys (Nature Research & Penny, 2017), Global Young Academy (GYA) (Coussens, 2017), Vitae (Vitae, 2018) and National Science Foundation (Phou, 2014) surveys were selected because they are carried out by prestigious organisations with a specific interest in ECRs in the sciences, are conducted on a regular basis and completed by a large number of respondents; questions from the EMCR Forum (Hardy et al., 2016) and University of Melbourne surveys (Bell & Yates, 2015; Coates & Goedegebuure, 2007) were selected because they were conducted in Australia and for academic populations of interest. Surveys conducted by both Nature and GYA are international, the National Science Foundation survey is conducted within USA and Vitae PIRLS and CROS surveys are conducted within the United Kingdom. I sought and received permission for reproduction of questions, where appropriate.

I then combined and modified the questions to create a question bank for this survey relevant to the research questions and the Australian context. I developed new questions for particular topics where I could find no validated question elsewhere.

The themes for the questions covered the issues addressed in the theoretical framework, thus reflecting those of Rosser (2004) and Basak & Govender (2015) (workload, job security, job satisfaction, challenges, mentoring and supervision, career planning, intention to leave, career breaks and expectations about the career). These questions were supplemented by questions seeking demographic information which included the institution type, research discipline, country of birth, family situation and work arrangements. As mentioned above, I included more questions following the focus group discussion.

See Appendix B Final Questions with Authors.

3.8.5.2 Validation of Questions

I performed a content variability index (CVI) using a relevance and clarity assessment tool (Appendix E) according to the methods described by Polit et al. (2007) and Polit & Beck (2006). A CVI is a rating between 0 and 1 indicating the proportion of agreement between experts of the validity of survey instrument. Four experts (two research experts and two experts in statistical methods) assessed all the items which were specifically created or adapted for use in this questionnaire for relevance and clarity.

CVI for clarity = 1 for all new questions. This indicates total agreement by all experts. CVI for relevance = 1 for all but two questions where CVI = 0.75. The CVI for the whole scale = 1 for each.

Q11 “Do you live with a partner or spouse?” scored a low rating for relevance from two experts. The possible answers were:

- Yes –partner of the opposite sex
- Yes – same sex partner
- Yes – prefer not to specify
- No

This question is an adaptation of a question from Bell & Yates (2015) with, in this case, the "yes" answers split into the three variations of "yes". The inclusion of the yes/no answer to this question was to test whether the existence of a partner at home influenced matters such as work/life balance or overall job satisfaction as has been reported by Ryan et al. (2012). The reason for the detail of this question, which is likely to be what has led to the low scores for relevance, was included at the suggestion of staff at Science in Australia Gender Equity (SAGE) who were interested to know if parents from same sex relationships had difficulties which were different from those with partners of the opposite sex, such as problems with childcare or difficulties accessing parental or personal leave to care for children.

An epidemiologist who reviewed the questions noted that she believed this question is really about social support, which may or may not be family, especially among the foreign-born whose parents are often overseas. She questioned the relevance of collecting data on same sex relationships, on the basis that there is not enough data collected in this questionnaire to thoroughly explore the issue of sexual orientation in STEMM. Further detail provided her valid reasoning that the small number of responses among those living with a same sex partner, in conjunction with responses to Q36 regarding "the attitude towards people of my sexual orientation", would not be sufficient to draw any conclusions. In fact, the number of respondents who disclosed they were in a same sex relationship and had children

was very small, however I maintain it could have been useful had the number of respondents been higher.

Q72 “Do you have a long-term health condition or disability that restricts you in your everyday activities and has lasted, or is likely to last, for more than 6 months” scored a low rating for relevance from one expert. This question was included at the suggestion of a member of the focus group panel who herself has a chronic disability and has found it has impacted her career as it has prevented her from readily re-locating, a practice common in STEM disciplines. The answers to this question which show 12% of respondents do have such a condition suggest it was a worthwhile inclusion.

Other comments from the epidemiologist include the following:

Q6 “Where were you born?”: “The place of birth is relevant only in the context of where the researcher spent most of his life, where he was educated, and perhaps his nationality.” While this is certainly true, we offered a drop-down list of the top 10 countries from which the Australian HDR population is drawn and an “other” box in order to minimise entry errors. I am confident the data collected are sufficiently accurate for my purposes.

Q73 “How does your job as an early-career researcher meet your original expectations? If you wish to offer an explanation, please do so in the comment section.

- my job is much better than I expected
- my job is better than I expected
- my job meets my expectations
- my job has more difficulties than I expected
- my job has many more difficulties than I expected”

The reviewer commented that her gut response here was "could she provide multiple answers? You are asking two questions: whether the job meets expectations; and whether the difficulties met or exceeded expectations.". She said that the best job she ever had, that far exceeded her expectations had presented limitless, unexpected difficulties and that no option for 'did not meet expectations'. While again her points are valid, none of the 123 open text responses in the related comments box which followed indicated that this was an issue.

It is noted that one assessor (a research expert) commented that she did not agree with the definition of a mentor in Q42 "A mentor is someone who is there to assist you achieve your personal, academic and career exploration goals. This person is not necessarily your supervisor. Do you have a mentor?" She pointed out that a mentor's role is not so much to "assist" an individual's achievements, but rather to advise and support. The reviewer made the comment that the question should have read "A mentor is someone who has assisted you…"

I carried out a Cronbach's Alpha analysis (Heritage et al., 2018) to determine internal consistency in the on-line survey answers. This analysis was performed on the data set of 33 Likert-type variables (not including the created variables) which had been created for modelling job satisfaction. Some scale variables (Q32-1, Q32-2, Q36-6, Q37-1, Q44, Q73, Q75) had been "transformed" in SPSS to ensure all the responses ran consistently, i.e. from low to high. A Cronbach Alpha score should be 0.8-0.9, although anything above 0.7 is considered suitable for most research purposes (Heritage et al., 2018). The Cronbach's Alpha = 0.91 indicated good consistency. A second Cronbach's Alpha test for which the sample was split randomly into two batches further tested variability; the scores of 0.859 and 0.788 showed no evidence of bias. I thus showed the data set is suitable for research purposes.

3.8.6 Semi-Structured Interviews

I interviewed eight women who had recently left the research environment for other types of workplaces as part of this project.

Using an iterative approach (Minichiello et al., 2008) , I employed semi-structured interviews with the aim of gaining detailed understanding of individual perspectives of people in the research environment. This followed the method used by the GYA research projects and the National Science Federation for interrogating the same type of populations (Friesenhahn & Beaudry, 2014; Geffers et al., 2017; Phou, 2017). I looked to build on the work of three studies from the USA which have investigated job satisfaction and intention to leave from STEMM disciplines (Bozeman & Gaughan, 2011; Grinstein & Treister, 2018; Miller & Feldman, 2015) which have differing findings about job satisfaction and intention to leave, on interviews of McAlpine & Emmioğlu (2015) with international ECRs in STEM, and on the work of Gardner (2012) about women in STEMM by exploring the decision making processes of these young women about their exit from academic research.

The interviews explored the views of eight women who had recently left academic research. I selected one-on-one, in-depth, semi-structured face-to-face or Skype video interviews as the most appropriate method of data collection to explore and understand their experiences (Creswell & Plano Clark, 2017). The interviews were held between December 2018 and May 2019 and typically lasted for a period of about an hour (between 35 and 84 minutes). I obtained written consent for all interviews; each was recorded and transcribed verbatim, then anonymised and subsequently analysed.

I conducted the semi-structured interviews using a responsive interviewing technique which emphasises the interview's conversational and relational aspects (Rubin & Rubin, 2012). In all cases interviews were held in an environment selected by the participant. Once

we had covered the core questions, which included collection of demographic data, (see Appendix C) the conversation was left to follow its natural course. All participants agreed to be known in any publication of the research by a pseudonym and were advised that their previous and current workplaces would be anonymised.

3.8.6.1 Interview Participants

The details of the eight women interviewed are presented in Table 9. The selection criteria for these participants were simply that I was aware, or became aware, they had recently left STEMM research for a new career path, and that they were willing to share their stories. I sought diversity in demographic factors which I believed might influence the findings such as age, number of years postdoctoral and discipline. It was not originally my intention to interview only women, however no eligible men came forward (and perhaps another study could usefully repeat the interviews with men).

By the time I had the completed the eighth interview, there was a range of "next careers" for the interviewees. While this range of careers cannot be claimed to be comprehensive, given the possible alternate careers for scientists which are identified by career advisory services and references discussing options for higher degree students and ECRs (Edwards et al., 2011; Hadlow, 2019; Rochen Renner, n.d.; Woolston, 2018; Zaringhalam, 2016), it appeared the interviews had reached saturation of experiences within the academic environment. At the same time, no significant new points were raised (Grove & Overton, 2013) about the decision to leave, so I chose not to conduct any more interviews. Although there is no one correct number for qualitative interviews, other researchers have identified key themes had emerged following only six interviews, with subsequent interviews confirming the findings (Guest et al., 2016). I sought to balance the number of interviewees with the value of the data (Mason, 2010).

Table 9:

Interview Participants

Participant's Pseudonym	Years Post Doctoral Award	Previous Discipline	Current Occupational Sector
Margaret	2	Epidemiology	Government
Sarah	4	Medical research	Medicine
Pixie	5	Marine Ecology	Consultant
Tania	6*	Agricultural & veterinary sciences	Science Communication (as an Academic)
Cecile	6	Medical research	Industry
Rosie	8	Gynaecology	Research Administration
Laura	10	Biomedical research	Science writing
Daisy	18	Medical research	Not working

* 22 years after PhD awarded but the intervening years have been spent outside the academic research environment

While I acknowledge there were only eight interviews, I expect that the views of these women are representative of ECRs in academic STEMM in Australia because they have been drawn from a range of universities and disciplines and from a broad range of demographic sectors including location, age and family. Further, because their experiences are in keeping with those included in the research of others (Choo et al., 2019; Clark & Horton, 2019; Gardner, 2012) these views might be representative of women ECRs all over the world. That the comments in the interviews are consistent with those from the survey data also alleviates concerns about the number of interviews.

All the women except for Daisy and, to a degree, Tania, may be considered to be ECRs as defined for this project, i.e. up to 10 years postdoctoral. Daisy was 18 years post PhD at the time of her interview, but I included her included as she had indicated her

problems began during her late ECR time. I believed her views about that period and about her later decisions, after the ECR time, would be both relevant and interesting. Tania could be regarded as six years postdoctoral (calculating in accordance with substantial career interruption, although her PhD was actually conferred in 1997).

3.8.7 Journaling

A fourth element of this mixed methods approach was reflective journaling. I have worked in medical research for most of my career and my view of the research environment is necessarily coloured by that experience.

I kept journals for recording reflections regarding both my research and my work life which brings me into daily contact with ECRs, thus permitting an "insider" approach. The journal has permitted me to monitor my impact on the data and keep track of my progress. It has provided evidence of my endeavours to maintain transparency (Grbich, 2018) and to prevent the introduction of bias.

I have recorded my own observations about the ECR experience and about factors which contribute to success, or otherwise, in the research environment at large during the life of the project. I have also recorded observations made to me by others working in the research environment. This reflective journaling has also provided an aide memoir and permits recollection of situations or conversations in context.

3.9 Data Analysis

The focus group discussion, semi-structured interviews and journals provided qualitative data for this project. The pilot survey and on-line survey data gathered demographic information and broad scale quantitative responses from the ECR population as

well as providing qualitative data in the open text questions. Methods of data analysis for both quantitative and qualitative data will be discussed in the following pages.

3.9.1 Quantitative Data Analysis

A range of methods was used to analyse the quantitative data collected in the on-line survey, including descriptive and inferential statistics, structured equation modelling and logistic regression which are each described in detail below.

3.9.1.1 Descriptive and Inferential Statistics

I analysed data using IBM SPSS v26 and MS Excel v15 for Mac for descriptive and inferential statistics. I employed SPSS for all analyses of questions where an answer was required from all respondents. The most usual method of analysis was use of frequencies of descriptive statistics.

I later compared on-line survey responses for ECRs drawn from different cohorts by selection of data according to variables and thus investigated differences and similarities for characteristics including gender, different work types (i.e. research only vs. research and teaching or research and clinical), and number of years postdoctoral or age in order to further my understanding of experiences for the different cohorts.

Where respondents were able to select one or more answers for a question (such as Q53 “In which areas have you undertaken, or would you like to undertake, training in these research and academic skills?”) I performed the calculations using MS Excel for Mac, v16.

Statistical significance for results was calculated, where appropriate, using an online Chi-square testing tool (Preacher, 2001). Results were taken to be statistically significant where significance, measured as “p value” was less than or equal to 0.05.

3.9.1.2 Structural Equation Modelling

Structural equation modelling (SEM) was employed in SPSS AMOS v25 to estimate the factors that best correlate with job satisfaction. SEM is a general framework for mapping the relationship among a set of variables and is a combination of factor analysis and regression models (Signoret et al., 2018). SEM allows error co-variance between various predictors that are highly related to each other (Kline, 2016). Prior to carrying out the SEM, as mentioned in Chapter 2 I conducted a systematic literature review of articles published since Johnsrud & Rosser (2002) and up to January 2020 (the time of the search) where SEM was used to investigate job satisfaction and any factors relating to it in academia. The method for this literature review is discussed in detail below.

3.9.1.2.1 Systematic Literature Review of the Use of Structural Equation Modelling in Academic Research Workplaces

In order to begin the systematic literature review I used the search terms “structural equation modelling”, “job satisfaction”, “higher education” and “academia” in various combinations in the advanced search functions of the major databases to find articles that showed in either key words or abstract that they had used SEM to explore job satisfaction and related factors in the academic environment. These databases included EBSCO Host Academic Search Complete, Emerald Insight, Scopus, Taylor and Francis online, Web of Science, Wiley on-line library. When the search in Wiley on-line library was restricted to only "job satisfaction" AND "structural equation modelling" it brought up 16 records related to nursing which proved to be of interest for comparative purposes.

These records were exported to my reference management software Zotero; after removing duplicates 94 articles remained and these were individually examined for relevance. I rejected papers as not relevant if the focus was on topics which appeared to be out of scope.

These included corporate responsibility; corporate social responsibility; criminal justice; customer rage; financial performance; human capital management; involvement in sport; noise and job satisfaction in open plan work environments; organisational citizenship; organisational commitment for job dissatisfaction and employee silence; parental life satisfaction as a predictor for adulthood; quality of work; safety procedures and satisfaction; social justice, social networking site use; politics.

Sometimes the papers were too limited, usually because they focussed on factors which could have been of interest except these factors were the exclusive focus. Some examples of topics for these papers are collegiality between faculty; family-responsibilities and work-life balance; management and decision-making style; leadership styles; organisational commitment; predictors and outcomes of work-life balance factors for Hispanics; research productivity; trust in managers; role ambiguity. I also omitted papers (which really should not have come up in the search) where the workers were hotel staff; banking staff; economic crime investigators; service staff; environmental health officers; industry; licenced social workers; mental health workers; students or school teachers. Perhaps these came up in the search because of the word "job".

Following these searches, a search using the same terms in Google Scholar provided a huge list of references; when sorted by "most relevant" I added several more papers, notably a methodological review of the use of SEM in higher education (Green, 2016).

I note this literature review search did not bring up Rosser (2004) where she described the use of SEM and built a model of faculty members' intention to leave, supporting previous work on faculty members' job satisfaction. Investigation of citations of Johnsrud & Rosser (2002) (placed online in 2016) from 2011 onwards led me to more articles for consideration and eight new articles were added to the collection. These included some which discussed

models or frameworks for job satisfaction developed without SEM (Kinman, 2019; Kinman & Wray, 2020; Rosser & Tabata, 2010); I also included other papers which I had previously identified (Basak & Govender, 2015; Sutherland, 2017).

Table 10:

Papers which Discuss SEM and Models of Job Satisfaction

Authors	General Description
(Bashir & Gani, 2019)	Job satisfaction and organisational commitment of university teachers in India
(Blakewood Pascale, 2018)	Model of intention to leave with respect to satisfaction for women faculty in STEM disciplines in the United States
(Ghasemy et al., 2019)	Job satisfaction and job performance of academics in Malaysian universities with social sciences backgrounds within a framework based on affective events theory. Examines the influence of workplace features such as involvement, workload and welfare on job satisfaction through role conflict, as a work event, and positive affect
(Hogan et al., 2015)	Uses a model of Work-Life Conflict to examine the impact of job involvement, workaholism, work intensity, organisational expectations and support, and having children on work hours, work-life conflict and psychological strain in male and female academics
(Johnsrud & Rosser, 2002)	Models faculty members' perceptions of their work lives with respect to intention to leave
(McNaughtan et al., 2019)	Models of employees' perception of their work conditions and sense of empowerment, in relation to job satisfaction, which has been found to increase productivity and reduce turnover.
(Rosser, 2004)	A model of how demographic variables, professional and institutional worklife issues, and satisfaction interact to explain faculty intentions to leave
(Rosser, 2005)	Uses a two-group structural equation model to investigate the change in faculty members' perceptions of their worklife and satisfaction over time.

After careful consideration of all these papers, I identified 10 papers, shown in Table 10 as describing models using criteria relevant to my study. Upon close inspection, even

though they included valuable background information, only those by Johnsrud and Rosser (2002), Rosser (2004) and Rosser (2005) truly included the factors and concepts I wished to test in my model. The work of Blakewood Pascale (2018) is a possible exception. She uses descriptive statistics and SEM techniques to identify factors related to STEM women faculty members' intention to leave and provides useful insights for higher education.

In conducting this systematic review I was able to confirm that there appears to be no research which describes conceptual models of factors contributing to job satisfaction for people employed in the scientific environment, or the research environment, in universities or research institutes and which could be applied to quantitative data. While Rosser's models can certainly be applied to quantitative data, my model described in Chapter 4 introduces additional factors which I believe are key to the STEM environment for ECRs.

3.9.1.2.2 Preparation for the Modelling

In preparation for running the model, I created a dataset "survey data for model" containing the responses to 27 questions. It was necessary to reverse the scoring for the questions within Q32, Q36, Q37 and for Q44, Q73, Q75 for ease of interpretation, thus ensuring that all responses indicated a range from low satisfaction or agreement to high. In addition, five new variables were created which I named "Contractstability", "Total hours", "Expected hours", "Excess working hours" and "Questionable prac". Details of the creation of these factors are given in Table 11.

3.9.1.2.3 Factors Selected

The questions were selected from the quantitative survey data as being reflective of factors previously identified in the literature as affecting job satisfaction. As illustrated in Table 11, for the purposes of the model, I divided these factors into four constructs

representing two hierarchical layers of impact on the individual's job satisfaction, institutional factors and personal factors.

- Institutional factors
    - Institutional choices – impacting workplace culture
    - Working conditions - the HR aspects and conditions of the individual's employment
- Personal
    - Personal me – how I feel, my opinions and mindset
    - Personal other – how I feel about what others do to me/ things imposed on me

Table 11:

Model Constructs

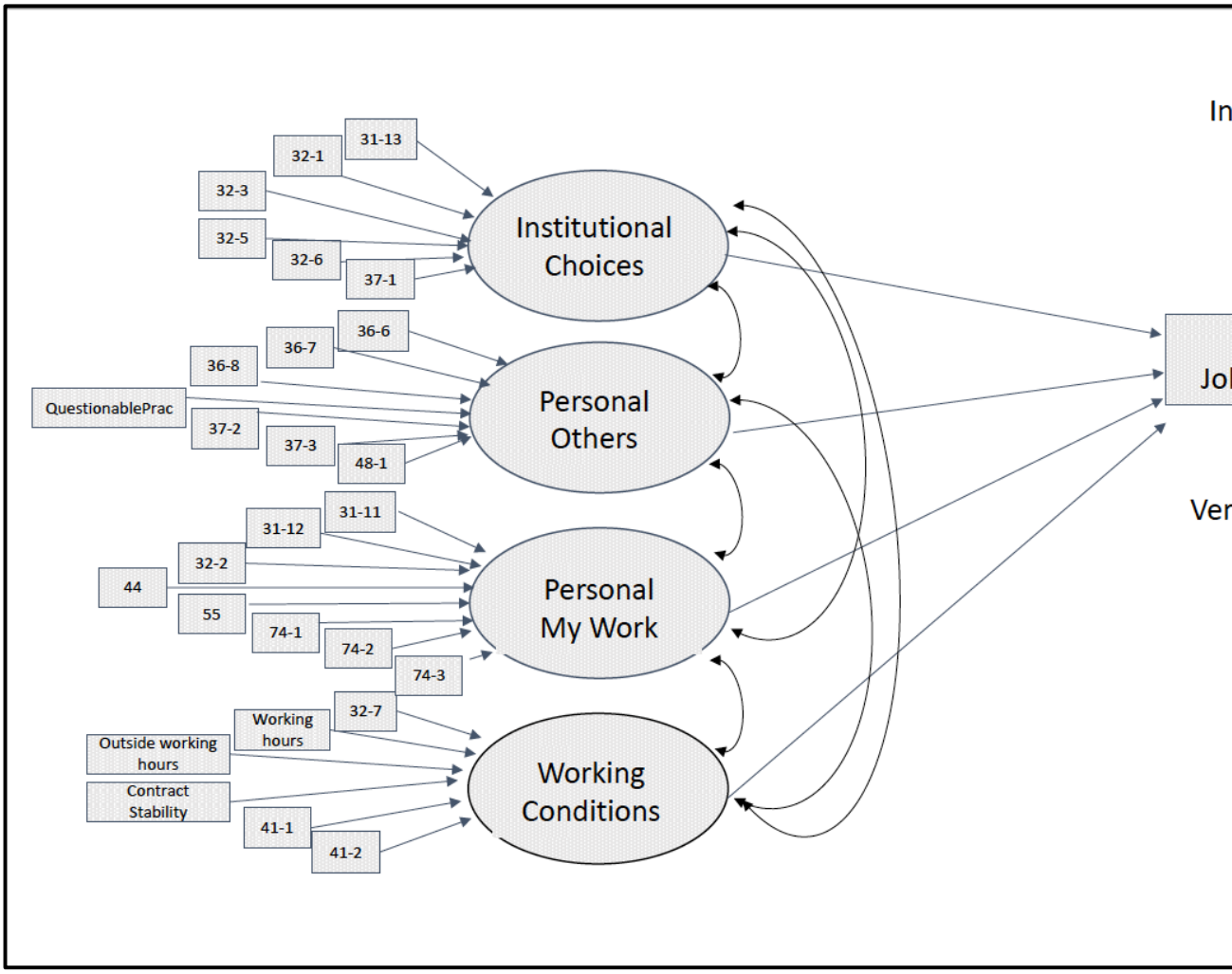
Model Constructs	Questions Included
Institutional Choices	31-13 inclusion and diversity 32-1 Criteria for promotion 32-3 Leadership and management 32-5 Support for career 32-6 Resources 37-1 Inequitable hiring
Working conditions (HR type matters)	"Contractstability" – an index scaled between 0 and 5 calculated as No. of post doc appointments/no. of years PostDoc multiplied by Contract length (in years)/ no. location changes "Total hours" Total hours worked (per week "Expected hours" Total hours worked (per week) divided by 10 to scale to a comparable range to the Likert responses "Excess working hours" (total hours per week – contracted hours – calculated from fraction of employment) divided by 10 to scale to a comparable range to the Likert responses 32-7 Flexibility 41-1 Manage demands home and work 41-2 Quality of life
Personal Others	36-6 Attitude re age 36-7 Attitude re gender 36-8 Attitude re ethnicity 37-2 Harassment 37-3 Lack of support 48-1 Review process overall "Questionableprac" total questionable research practices observed inside and outside institution
Personalme	31-11 Influence decisions 32-2 Culture of workplace 31-12 Safe 44 Mentoring beneficial 55 Confident of prospects 74-1 This is a poor time 74-2 If I had to do it again 74-3 My job is a source of strain

3.9.1.2.4 Model Version 1: Job satisfaction Q75 with reference to external constraint Q31-7 "I have good job security"

In the initial model, illustrated in Figure 6, the individual variables described in Table 11 were grouped into the four latent variable constructs described above and modelled against Q75 "How would you rate your overall satisfaction with your current job?" as a response variable for job satisfaction. Pathways signifying interactions between the layers representing the institution and the individual as well as within these layers, are indicating by bi-directional arcs on the diagram.

Figure 6

Model Version One



3.9.1.2.5 AMOS v.25 Analysis parameter settings

The model utilizes 891 cases, but the data set used for modelling is partially incomplete with not all questions answered by all respondents. Maximum likelihood was used to estimate missing means and intercepts and both saturated and independence models were calculated. The model as depicted in Figure 28 in Chapter 4 (Section 4.4.2.1) was constructed using the visual modelling interface in AMOS (Arbuckle, 1983). One arbitrary branch within each complete set of pathways for each latent variable was set to a covariance of 1 as were all error terms on both input and response variables. Output estimations were given as both standardised estimates and squared multiple correlations and a full suite of goodness-of-fit measures were interrogated.

3.9.1.3 Logistic Regression

Logistic regression attempts to predict which level of a criterion variable (or categorical outcome) a case (a participant) is likely to belong to, and examines the accuracy of this prediction with regard to their actual level of the criterion available (Heritage et al., 2018). I employed SPSS to run binary logistic regression calculations to identify factors leading to intention to leave the academic research.

To do this, in preparation for running the model, I created a dataset “survey data for intention to leave” from the complete data set “survey data for working with”. I created a new binary variable “Intentleave” in SPSS, setting all “yes” answers to “1” and “no” answers to “2”. It was necessary to reverse the scoring for some questions within Q31, Q48, Q55 and Q74 to ensure the high number responses indicated intention to leave.

For Model 1, variables relating to the work environment and support were measured against “intentleave”, a variable created from responses to Q61 whereby the four “yes” responses were transformed to become yes to permit comparison with “no”.

In Model 1 we used variables Q2 (years post doc), Q4 (gender), Q11 (do you have a partner), Q13 (do you have children at home), Q15 (do you have carer responsibilities), and all variables of Q31-(1-13) and all variables in Q32-(1-7) all of which pertain to job satisfaction.

Given the original coding of stress factor items in the on-line survey, to avoid negative factor loadings, stress items were reverse-coded.

The omnibus model for the logistic regression was statistically significant for the model row, therefore my predictors in combination significantly improve the predictive accuracy of this model.

$X^2(N=559, df=25) = 57.7, p<0.001$

The model was 100% accurate in its prediction of intention to leave but was not successful in prediction of intention to stay (1%); overall predictability is 82.6%. A Hosmer and Lemeshow “goodness of fit” test = 0.276 confirmed that the model was not a good fit for the data.

The inclusion of “number of years post doc”, “do you live with a partner”, “I am confident my work contributions are valued”, “I find my work rewarding” and “I have good career prospects” significantly improved the predictability of the model.

3.9.2 Qualitative Data Analysis

Qualitative data from the interviews, reflective journal and free text responses from the on-line survey were analysed using thematic analysis in an interpretive process described below.

3.9.2.1 Thematic Analysis

I used NVivo v12 for Mac, an accepted analysis tool which helps researchers analyse data systematically (Denscombe, 2017) for thematic analysis of the qualitative data. The themes for qualitative analysis were initially developed from the themes of the questionnaire. Thematic analysis offers researchers the advantage of flexibility, however the researcher must be aware that the analysis has the potential to be influenced by personal preconceptions (Braun & Clarke, 2006).

A recursive, interpretive process as recommended by Braun & Clarke (2006) was applied to data collected from the focus group, all interviews and from open text questions. Transcripts were analysed using NVivo by coding the data by the major themes from the interviews, and the major themes from the on-line survey data, then by identifying recurring themes in both sets of data, and ultimately preparing a descriptive analysis. The qualitative data from all sources were particularly helpful in answering the overarching research question, "What are the relationships between ECR job satisfaction or dissatisfaction and their likelihood of staying in science?" as well as sub-question b) "What are the motivations for ECRs leaving the sciences?" and sub-question c) "What are the specific features of the experiences and environment of those ECRs who remain in the sciences?" which can only partially be answered by the on-line survey.

Final themes are listed in Table 12; the full list of themes and sub-themes can be found in Appendix D. The same general themes were employed in Zotero v12 the referencing software used for categorising source material for the project, in order to keep them consistently in mind.

Table 12

Major Themes for Qualitative Analysis

Theme Header	
Alternate Career	Mentoring
Career Planning	Professional Development
Challenges	Recommendations for Change
Expectations of ECRs	Success as a Researcher
Institutional Infrastructure	Supervision
Intention to Leave	Vocation (love of science)
Job Satisfaction	Workplace Culture
Leadership	

In performing these analyses and interpreting the data it was possible to identify the most significant factors which contribute to the ECR environment, and to job satisfaction/dissatisfaction for ECRs, the most significant factors which contribute to intention to leave for ECRs and steps which ECRs believe could be taken to improve their work environment and job satisfaction.

3.9.2.1.1 Thematic analysis for Interviews

Using a simple coding system within NVivo I examined the interview transcripts to identify similarities and differences between the way in which participants had experienced their previous careers, reached their decisions to leave those careers and the consequences, to

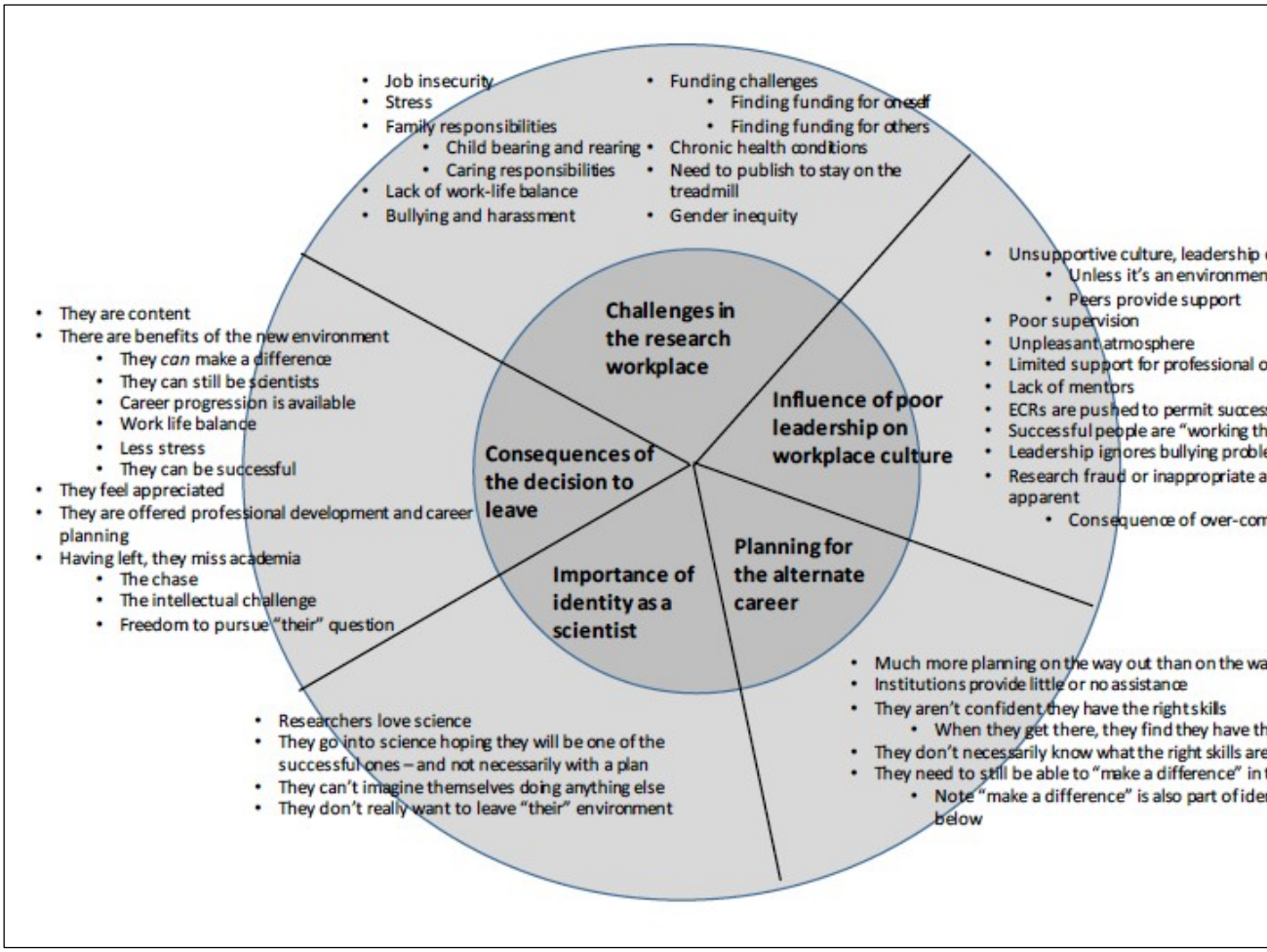
them, of the changes. The relationships between the emerging patterns and themes corresponded with the project's conceptual framework of factors contributing to job satisfaction (which had also informed the themes for questions in the survey).

I extracted excerpts of the transcripts by theme, then reviewed them and examined them again in context in order to check I was interpreting them correctly. I examined instances where there were similar responses, by theme, from amongst the interviewees, and, separately, instances that typified differences between them. This iterative approach of checking my interpretations while sorting and comparing the data, until I believed saturation had been reached, follows the example of Mobius et al. (2014) after the technique advocated by Barnacle (2005).

Following this initial analysis of the data I gathered the themes into five empirically grounded groupings: challenges in the research workplace, influence of poor leadership on workplace culture, planning for an alternate career, the importance of identity as a scientist and the consequences of a decision to leave which later contributed to the revised conceptual framework for job satisfaction and intention to leave. The themes are illustrated in Figure 7 (reproduced from the manuscript "Why eight women left academic research, and where did they go?" which is currently under review.

Figure 7:

Recurring Interview Themes



3.9.2.2 Word Clouds

I used the query facility in NVivo 12 for Mac which permits a count of word frequencies and generation of word cloud images to provide illustrations of the themes which were emerging from open text responses for selected questions in the on-line survey and from a section of the focus group discussion. Images were generated for the top 500 words with a minimum length of three letters long and including stemmed words. In addition to the standard "stop words" I excluded the names of interview participants. I also performed a quantitative thematic analysis of these texts, comparing counts of words demonstrating job satisfaction compared with those demonstrating job dissatisfaction (see Table 21 in Chapter 4).

3.9.2.3 Quotations from On-line Survey Participants

Quotations taken from open-text responses of on-line survey participants are employed throughout Chapters 4, 5 and 6. All participants were allocated a participant number by the LimeSurvey software. In order to protect the anonymity of participants the respondents have been allocated a new number derived from their participant number. In order to do this, I copied the participant numbers and the data for each open text question into an excel worksheet; I then performed a calculation to create a new participant number to act as a synonym for each participant by performing a calculation. I was then able to use the "find" function to match each quote to the participant's new synonym.

3.9.3 Validation of Data

Validation of data is important for maintaining the quality of research. (Heritage et al., 2018) considered "validation" as the measurement of the accuracy of findings based on research interpretation and participants' expression. The process of validation is to establish

the “trustworthiness” of the research, and researchers in this field use different terms to denote this concept such as “credibility, authenticity, transferability, dependability and confirmability” (Creswell, 2013). Creswell (2013) suggested a range of eight different strategies for validation of qualitative research, which include checking for mutual trust between researcher and participants, triangulating the information from different sources, having participants check results and external auditing. In social research, triangulation involves triangulation of theories, triangulation of methods, triangulation of data from various sources and triangulation among analysis Creswell, 2013; Denzin, 2012).

3.9.3.1 Inter-rater reliability

In order to determine inter-rater reliability of thematic analysis for interviews and open-text on-line survey answers, CJ (Principal Supervisor) and I each coded all 123 open-text comments to Q73 “How does your job as an early-career researcher meet your original expectations? If you wish to offer an explanation, please do so in the comment section.”

Using NVivo v12, coding was done in a separate project against themes from my theme framework, which had been developed deductively from the literature and early passes through the qualitative data. When the two documents were compared using the NVivo coding comparison tool, a very high level of agreement was found, other than in the node “Challenges” which has many sub-themes and sub-sub themes within the theme “challenges”. I updated the themes table to provide better clarity and the quotes were subsequently re-coded on a consensus basis.

Our detailed examination of the differences in coding showed that it would be beneficial for clarity of purpose to re-structure the theme categories in some areas.

- "parental caring" was added to "family responsibilities", taking "child responsibility" from "Issues for women", while leaving "child bearing" in "Issues for women".
- "Work-life balance" was reorganised to include "workload (too much work)" and a new sub-sub-theme "too much administration" in addition to the five sub-sub-codes already there.
- Within "inappropriate behaviours", "sexual harassment" was included in "bullying and harassment" as a sub-sub-theme. "Harassment of basis of gender" was removed altogether as it could be incorporated in "sexual harassment".
- A new sub-sub- theme "feel isolated" was added to "factors contributing to job dissatisfaction".

3.9.3.2 Validation through Triangulation

In this research project, "triangulation" means triangulation of data sources. I obtained trustworthiness of the qualitative data collected and of the subsequent analysis by triangulation of my data sources (Creswell, 2013; Denzin, 2012), comparing interview data with results from the on-line survey and focus group discussion, as well as making comparisons with sources in the literature. While most of the on-line survey questions provided quantitative responses, there were a number of questions which permitted open-ended answers. The same methods of analysis were applied to these questions as to the other qualitative data and provided consistent responses.

I further confirmed trustworthiness by sharing the draft manuscript reporting the findings of the interviews with the interviewees and inviting comment (Creswell, 2013); none of the interviewees disagreed with my observations. Last, notes kept in my journal throughout the project provided a further source for triangulation of data collected by other methods.

3.10 Summary of Research Methodology and Design

In Chapter 3 I have described in detail the ethics approvals, the theoretical and conceptual frameworks for the project and then each of the research methods employed for both data collection and analysis. In Chapters 4, 5 and 6 I will address the findings and answer each of the research questions.

Chapter 3 References

Åkerlind, G. S. (2005). Variation and commonality in phenomenographic research methods. Higher Education Research & Development, 24(4), 321–334. https://doi.org/10.1080/07294360500284672

Antunes, D. (2009). The Transformative Approach. SSRN. https://doi.org/Antunes, Don, The Transformative Approach (February 2, 2009). Available at SSRN: https://ssrn.com/abstract=1336597 or http://dx.doi.org/10.2139/ssrn.1336597

Barnacle, R. (2005). Interpreting interpretation: A phenomenographical perspective on phenomenography. In J. A. Bowden & P. Green (Eds.), Doing developmental phenomenography. RMIT University Press.

Basak, S. K., & Govender, D. (2015). Theoretical Framework Of The Factors Affecting University Academics Job Satisfaction. International Business & Economics Research Journal (IBER), 14(2). https://doi.org/10.19030/iber.v14i2.9167

Bashir, B., & Gani, A. (2019). Testing the effects of job satisfaction on organizational commitment. Journal of Management Development. https://doi.org/10.1108/JMD-07-2018-0210

Bell, S., & Yates, L. (2015). Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne. https://womeninscienceaust.org/2014/06/15/women-in-the-scientific-research-workforce-identifying-and-sustaining-the-diversity-advantage/

Blakewood Pascale, A. (2018). Supports and Pushes: Insight into the Problem of Retention of STEM Women Faculty: NASPA Journal About Women in Higher Education: Vol 11, No 3. NASPA Journal About Women in Higher Education, 11(3), 247–264. https://doi.org/10.1080/19407882.2018.1423999

Bozeman, B., & Gaughan, M. (2011). Job Satisfaction among University Faculty: Individual, Work, and Institutional Determinants. The Journal of Higher Education, 82(2), 154–186. https://doi.org/10.1080/00221546.2011.11779090

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Browning, L., Thompson, K., & Dawson, D. (2016). It takes a village to raise an ECR: Organisational strategies for building successful academic research careers. International Journal for Researcher Development, 7(2). www.emeraldinsight.com/2048-8696.htm

Browning, L., Thompson, K., & Dawson, D. (2017). From early career researcher to research leader: Survival of the fittest? Journal of Higher Education Policy and Management, 39(4), 361–377. https://doi.org/10.1080/1360080X.2017.1330814

Choo, E. K., Byington, C. L., Johnson, N.-L., & Jagsi, R. (2019). From #MeToo to #TimesUp in health care: Can a culture of accountability end inequity and harassment? The Lancet, 393(10171), 499–502. https://doi.org/10.1016/S0140-6736(19)30251-X

Christian, K., Johnstone, C., Larkins, J., & Wright, W. (2019, September 17). The need to seek institutional approval to survey staff –was this a misunderstanding of the purpose of Guideline 2.2.13 in the National Statement on Ethical Conduct in Human Research? Research Ethics Monthly. https://ahrecs.com/human-research-ethics/the-need-to-seek-institutional-approval-to-survey-staff-was-this-a-misunderstanding-of-the-purpose-of-guideline-2-2-13-in-the-national-statement-on-ethical-conduct-in-human-research

Christian K, Johnstone C, Larkins J, Wright W, Doran MR. A survey of early-career researchers in Australia. Rodgers P, Deathridge J, Lijek RS, Rolf H, Hussain T, editors. eLife. 2021 Jan 11;10:e60613

Clark, J., & Horton, R. (2019). What is The Lancet doing about gender and diversity? The Lancet, 393(10171), 508–510. https://doi.org/10.1016/S0140-6736(19)30289-2

Coates, H., & Goedegebuure, L. (2007). The Australian Academic Profession in 2007 Survey Methodology and Response Analysis. Australian Council for Educational Research.

Coussens. (2017). GloSYS Africa Appendix 1_Survey and Consent v2.0 (Global Young Academy, Ed.).

Creswell, John W. (2015). A Concise Introduction to Mixed Methods Research. Sage.

Creswell, John W. (2013). Research Design Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.). Sage.

Creswell, John W, & Plano Clark, V. L. (2017). Designing and Conducting Mixed Methods Research (3rd ed.). SAGE Publishing.

Denscombe, M. (2017). The Good Research Guide, 6th Edition (6 edition). Open University Press.

Denzin, N. K. (2012). Triangulation 2.0. Journal of Mixed Methods Research, 6(2), 80–88. https://doi.org/10.1177/1558689812437186

Denzin, N. K., & Lincoln, Y. K. (2005). The SAGE Handbook of Qualitative Research (3rd ed.). SAGE. https://epdf.pub/the-sage-handbook-of-qualitative-research.html

Edwards, D., Bexley, E., & Richardson, S. (2011). Regenerating the Academic Workforce. The careers, intentions and motivations of higher degree research students in Australia. Findings of the National Research Student Survey. Australian Council for Educational Research. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0009/1490940/RAW_Combined.pdf

Friesenhahn, I., & Beaudry, C. (2014). Global State of Young Scientists Project Report and Recommendations. Global Young Academy. https://globalyoungacademy.net/wp-content/uploads/2015/06/GYA_GloSYS-report_webversion.pdf

Gardner, S. K. (2012). "I Couldn't Wait to Leave the Toxic Environment": A Mixed Methods Study of Women Faculty Satisfaction and Departure From One Research Institution. NASPA Journal About Women in Higher Education, 5(1), 71–95. https://doi.org/10.1515/njawhe-2012-1079

Geffers, J., Beaudry, C., Yang, H.-C., Huang, F., Phanraksa, O., & Dominik, M. (2017). Global State of Young Scientists (GloSYS) in ASEAN: Creativity and Innovation of Young Scientists in ASEAN [Report]. Global Young Academy.

Ghasemy, M., Alvani, S. R., Abel, B. L., Cepeda-Carrion, I. F., & Cepeda-Carrion, G. (2019). Is Job Satisfaction of Social Sciences Scholars Predicted by Emotions, Job Performance, Work Events, and Workplace Features? A Demonstration of a Data-Driven Policy-Making Approach. Higher Education Policy. https://doi.org/10.1057/s41307-019-00172-y

Grbich, C. (2018). Course Notes for Foundations of Qualitative Methodologies, Data Collection and Analysis.

Green, T. (2016). A methodological review of structural equation modelling in higher education research. Studies in Higher Education, 41(12), 2125–2155. https://doi.org/10.1080/03075079.2015.1021670

Greene, M. J. (2014). On the Inside Looking In—Methodological Insights and Challenges in conducting qualitative insider research. The Qualitative Report, 19(29). https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1106&context=tqr

Grinstein, A., & Treister, R. (2018). The unhappy postdoc: A survey based study. F1000Research, 6, 1642. https://doi.org/10.12688/f1000research.12538.2

Grove, M., & Overton, T. (2013). Getting started in pedagogic research within the STEM disciplines. University of Birmingham.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In Handbook of Qualitative Research (pp. 105–117). Sage Publications, Inc.

Guest, G., Bunce, A., & Johnson, L. (2016). How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. Field Methods. https://doi.org/10.1177/1525822X05279903

Hadlow, T. (2019). Alternative careers for science graduates. GradAustralia. https://gradaustralia.com.au/career-planning/alternative-careers-for-science-graduates

Hardy, M. C., Carter, A., & Bowden, N. (2016). What do postdocs need to succeed? A survey of current standing and future directions for Australian researchers. Palgrave Communications, 2, 16093. https://doi.org/10.1057/palcomms.2016.93

Heritage, B., Allen, P., & Bennett, K. (2018). SPSS Statistics: A Practical Guide (Fourth). Cengage Learning Australia.

Hogan, V., Hogan, M., Hodgins, M., Kinman, G., & Bunting, B. (2015). An examination of gender differences in the impact of individual and organisational factors on work hours, work-life conflict and psychological strain in academics. The Irish Journal of Psychology. http://dx.doi.org/10.1080/03033910.2015.1011193

Horan, J., & Israel, M. (2016). Beyond the legal barriers: Institutional gatekeeping and real jury research. Australian & New Zealand Journal of Criminology, 49(3), 422–436. https://doi.org/10.1177/0004865815577768

Howes, L. M. (2017). Developing the Methodology for an Applied, Interdisciplinary Research Project: Documenting the Journey Toward Philosophical Clarity. Journal of Mixed Methods Research, 11(4), 450–468. https://doi.org/10.1177/1558689815622018

Johnsrud, L. K., & Rosser, V. J. (2002). Faculty members' morale and their intentions to leave: A multilevel explanation. The Journal of Higher Education, 71(1), 34–59.

Kinman, G. (2019). Effort-Reward Imbalance in Academic Employees: Examining Different Reward Systems. International Journal of Stress Management, 26(2), 184–192. http://dx.doi.org/10.1037/str0000128

Kinman, G., & Wray, S. (2020). Wellbeing in academic employees– a benchmarking approach. In Handbook of Research on Stress and Well-being in the Public Sector. Edward Elgar Publishing Limited.

Kline, R. B. (2016). Principles and practice of structural equation modeling (4th ed.). Guilford Press.

Mamiseishvili, K., & Rosser, V. J. (2011). Examining the Relationship between Faculty Productivity and Job Satisfaction. Journal of the Professoriate, 5(2), 100–132.

Marton, F. (1981). Phenomenography—Describing conceptions of the world around us. Instructional Science, 10(2), 177–200. https://doi.org/10.1007/BF00132516

Marton, F. (1986). Phenomenography—A Research Approach to Investigating Different Understandings of Reality. Journal of Thought, 21(3), 28–49. JSTOR.

Mason, J. (2017). Qualitative Researching. SAGE.

Mason, M. (2010). Sample Size and Saturation in PhD Studies Using Qualitative Interviews. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 11(3), Article 3. https://doi.org/10.17169/fqs-11.3.1428

McAlpine, L., & Emmioğlu, E. (2015). Navigating careers: Perceptions of sciences doctoral students, post-PhD researchers and pre-tenure academics. Studies in Higher Education, 40(10), 1770–1785. https://doi.org/10.1080/03075079.2014.914908

McNaughtan, J., García, H. A., Garza, T., & Harwood, Y. R. (2019). Empowering satisfaction: Analyzing the relationship between empowerment, work conditions, and

job satisfaction for international center managers. Tertiary Education and Management, 25(1), 83–99. https://doi.org/10.1007/s11233-018-09016-7

Merriam-Webster Dictionary. (n.d.). Definition of Methodology. Retrieved 3 September 2020, from https://www.merriam-webster.com/dictionary/methodology

Miller, J. M., & Feldman, M. P. (2015). Isolated in the Lab: Examining Dissatisfaction with Postdoctoral Appointments. The Journal of Higher Education, 86(5), 697–724. https://doi.org/10.1353/jhe.2015.0029

Minichiello, V., Aroni, R., & Hays, T. (2008). In-depth Interviewing: Principles, Techniques, Analysis. Pearson Australia Group. https://research.monash.edu/en/publications/in-depth-interviewing-principles-techniques-analysis

Mobius, M., Niederle, M., Niehaus, P., & Rosenblat, T. (2014). Managing Self-Confidence. National Bureau of Economic Research Working Paper.

National Health and Medical Research Council. (2018). National Statement on Ethical Conduct in Human Research (2007)—Updated 2018. Commonwealth of Australia, Canberra. https://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018

Nature Research, & Penny, D. (2017). Nature Graduate Survey 2017. https://doi.org/10.6084/m9.figshare.5480716.v3

Phou, K. (2014). Questionnaire for National Science Foundation Survey 2015. https://www.nsf.gov/statistics/srvyecd/#sd&qs&tabs-1

Phou, K. (2017). Profile of Early Career Doctorates: 2015 (Infobrief). National Science Foundation. https://www.nsf.gov/statistics/

Polit, D. F., & Beck, C. T. (2006). The Content Validity Index: Are You Sure You Know What's Being Reported? Critique and Recommendations. Research in Nursing & Health, 489–497.

Polit, D. F., Beck, C. T., & Owen, S. V. (2007). Focus on Research Methods Is the CVI an Acceptable Indicator of Content Validity? Appraisal and Recommendations. Research in Nursing & Health, 459–467.

Preacher, K. J. (2001). Calculation for the chi-square test: An interactive calculation tool for chi-square tests of goodness of fit and independence [Computer software]. http://www.quantpsy.org/chisq/chisq.htm

Ritchie, J., & Lewis, J. (2003). Qualitative Research Practice: A Guide for Social Science Students and Researchers (1st ed.).

Rochen Renner, B. (n.d.). LibGuides: Altac (Alternative Academic) Careers: STEM Resources. Retrieved 17 March 2020, from https://guides.lib.unc.edu/c.php?g=216166&p=1661253

Rosser, V. J. (2004). Faculty Members' Intentions to Leave: A National Study on Their Worklife and Satisfaction. Research in Higher Education, 45(3), 285–309. https://doi.org/10.1023/B:RIHE.0000019591.74425.f1

Rosser, V. J. (2005). Measuring The Change in Faculty Perceptions Over Time: An Examination of Their Worklife and Satisfaction. Research in Higher Education, 46(1), 81–107. https://doi.org/10.1007/s11162-004-6290-y

Rosser, V. J., & Tabata, L. N. (2010). An Examination of Faculty Work: Conceptual and Theoretical Frameworks in the Literature. In J. C. Smart (Ed.), Higher Education: Handbook of Theory and Research: Volume 25 (pp. 449–475). Springer Netherlands. https://doi.org/10.1007/978-90-481-8598-6_12

Rubin, H. J., & Rubin, I. (2012). Qualitative interviewing: The art of hearing data. SAGE. http://srmo.sagepub.com/view/qualitative-interviewing/SAGE.xml

Ryan, J. F., Healy, R., & Sullivan, J. (2012). Oh, won't you stay? Predictors of faculty intent to leave a public research university. Higher Education, 63(4), 421–437. https://doi.org/10.1007/s10734-011-9448-5

Signoret, C., Ng, E., Da Silva Heil, S., Tack, A., & Voss, U. (2018). Well-Being of Early-Career Researchers: Insights from a Swedish Survey. Higher Education Policy. https://www.researchgate.net/publication/323073459_Well-Being_of_Early-Career_Researchers_Insights_from_a_Swedish_Survey

Sutherland, K. A. (2017). Constructions of Success in Academia: An Early Career Perspective. Studies in Higher Education, 42(4), 743–759. https://doi.org/10.1080/03075079.2015.1072150

Trevors, J. T., Pollack, G. H., Saier, M. H., & Masson, L. (2012). Transformative research: Definitions, approaches and consequences. Theory in Biosciences = Theorie in Den Biowissenschaften, 131(2), 117–123. https://doi.org/10.1007/s12064-012-0154-3

Unluer, S. (2012). Being an Insider Researcher while Conducting Case Study Research. Qualitative Report, 17. https://eric.ed.gov/?id=EJ981455

Vitae. (2018). Background for Careers in Research Online Survey. https://www.vitae.ac.uk/impact-and-evaluation/cros

Walker, S., & Read, S. (2011). Accessing vulnerable research populations: An experience with gatekeepers of ethical approval. International Journal of Palliative Nursing, 17(1), 14–18. https://doi.org/10.12968/ijpn.2011.17.1.14

Woolston, C. (2018). Paths less travelled. Nature, 562, 611–614. https://doi.org/10.1038/d41586-018-07111-8

Zaringhalam, M. (2016, September 20). Why 'Alternative' Careers in STEM Aren't 'Alternative'. The Chronicle of Higher Education.

https://chroniclevitae.com/news/1549-why-alternative-careers-in-stem-aren-t-alternative

Chapter 4|

What are the Principal Factors that Shape the ECR Experience of Various Cohorts in the Sciences in Australia?

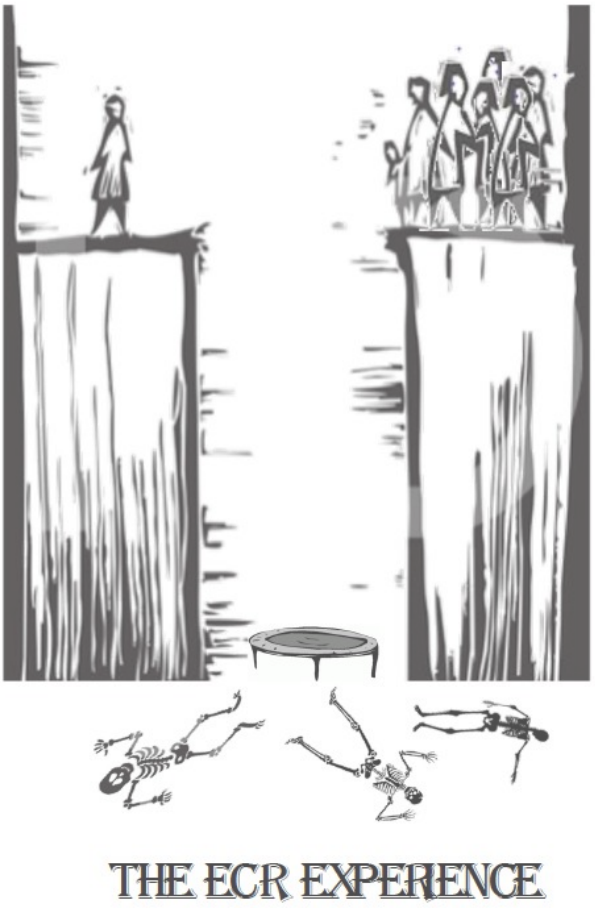


Image included with permission of Prof Don Newgreen

Introduction

In Chapter 4 I address the research sub-question "What are the principal factors which shape the experience of various cohorts in the sciences in Australia?" This chapter is divided into parts. The first part, Section 4.2 looks at the overall experience of ECRs in STEMM. It incorporates the published manuscript (Christian et al., 2021) which provides an overview of results from the on-line survey described in Chapter 3, supported by qualitative data collected in the in-depth interviews described in Chapter 3. These in-depth interviews are further examined in Chapter 5. This manuscript widely explores answers to the on-line survey questions, producing a picture of the workplace experience for ECRs in Australia. Section 4.2 also includes an article published in the peer-reviewed blog Research Ethics Monthly (Christian et al., 2020a) which discusses in detail findings about questionable research practices, one of the many topics addressed in Christian et al. (2021). Together these works, which have been developed as part of my PhD project, contribute to all my research questions through discussion about the workplace experience of ECRs, but particularly provide answers to the research sub-question specified above, "What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?".

Section 4.3 examines the principal factors known to contribute to the job satisfaction of ECRs working in STEMM disciplines. In Section 4.3.1 I examine job satisfaction by cohort, splitting the respondents by a range of demographic characteristics in order to examine differences in job satisfaction for a range of specific factors between these demographic groupings, In Section 4.3.2 I examine some individual factors for job satisfaction for the whole cohort, as described in the literature, providing comparison with findings from this study.

In Section 4.4 I describe my exploration for any additional factors for job satisfaction for ECRs in STEMM and explain the results of structural equation modelling of job satisfaction using the quantitative on-line survey data. In Section 4.5 I describe factors which do not appear to influence job satisfaction for the ECRs in this study, contrary to findings reported in the literature, and last, in Section 4.6, I describe factors which influence ECRs to stay in research.

4.2 Factors which Shape the Experience of ECRs in the Sciences

The on-line survey described in Chapter 3 underpins much of the research described in this thesis. It was set up to investigate the principal factors identified in the literature as supports or barriers contributing to the job satisfaction of ECRs and their relationship to intention to leave. Information collected in the interviews and focus group discussion provides further depth to this data; each of these data collection methods is described in Chapter 3. The factors relating to job satisfaction and intention to leave identified in the literature review (see Chapter 2) included job insecurity and stresses associated with it, work-life balance, workplace culture, resources for research, supervision and organisational leadership, and inequity, particularly gender inequity. Together, understanding of the supports and barriers in the ECR environment provides a picture of the overall experience of ECRs in STEMM. Given that findings from this project were to be viewed through a lens of satisfaction, the on-line survey asked questions which measured satisfaction in multiple ways.

4.2.1 Key Findings about the Workplace Experience

It becomes very clear, from findings from all the project's data sources (described on following pages, within this chapter), that the experience of ECRs is shaped by two opposing forces. On one hand, the ECRs love their actual work, their research, and many also record

their satisfaction with teaching and with supervising students. On the other hand, there is often deep dissatisfaction with the work environment. The principal cause of distress, lack of job security, colours everything else and leads to workplace stress and lack of work-life balance as ECRs struggle to attract more funding to enable continuing support of their positions. Lack of institutional investment in these ECRs, who are likely to only be working in the academic environment in the short term, due to lack of funding and few jobs, is reflected in poor supervision, lack of mentoring, lack of organisational support and a workplace culture in which questionable research practices are often overlooked.

These matters are discussed in detail in the manuscripts Christian et al. (2020a) and Christian et al.(2020c) which are integrated within this chapter as part of this thesis and which follow below.

4.2.2 Paper: "Research Culture: A Survey of Early-career Researchers in Australia" (Christian et al., 2021)

4.2.2.1 Position of (Christian et al., 2021) in the Thesis

The manuscript included here was developed as part of my PhD research and has been published in the journal eLife (impact factor 7.08 in 2019). eLife aims to publish work of the highest standards and importance in all areas of biology and medicine and is committed to working with the worldwide research community to promote responsible behaviours in research. The editors have a focus on early-career researchers in STEMM and expressed interest in publishing a version of this research, extended at their request, as a feature article.

This manuscript contributes to the answers to all four parts of the project's research question (See Section 1.4). In reporting findings on the ECR workplace, it addresses the main question "What are the relationships between ECR job satisfaction or dissatisfaction and their

likelihood of staying in science?" by identifying characteristics of the workplace which contribute to both job satisfaction and dissatisfaction. In answer to the first sub-question, "What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?" it illustrates many of the principal factors that shape the ECR experience. In answer to the second, "What are the motivations for leaving the sciences?" (addressed in more detail in Chapter 5) it provides evidence of motivations for intention to leave, in that there were many grievances reported about matters in the workplace. The paper discusses the fact that most respondents indicated they had considered leaving their positions, primarily motivated by job insecurity. In answer to the third sub-question, "What are the specific features of the experiences and environment of those ECRs who remain in the sciences?" it explores the reported "love of science" which appears to be the strongest motivation for staying, or trying to stay, working in the academic STEM environment.

The manuscript appears below as published in eLife. The pre-print manuscript Christian et al. (2020b) was modified, at the request of eLife, to include more demographics about the respondents, a word cloud and quantitative thematic analysis for Q76 "Why do you stay?". The editors also requested additional information about the ECRs' satisfaction with respect to their workplace's approach to diversity and inclusion and the influence of gender or work type on job satisfaction. Some material requested by the editors appears elsewhere within this thesis.

eLife

FEATURE ARTICLE

RESEARCH CULTURE

A survey of early-career researchers in Australia

Abstract Early-career researchers (ECRs) make up a large portion of the academic workforce and their experiences often reflect the wider culture of the research system. Here we surveyed 658 ECRs working in Australia to better understand the needs and challenges faced by this community. Although most respondents indicated a 'love of science', many also expressed an intention to leave their research position. The responses highlight how job insecurity, workplace culture, mentorship and 'questionable research practices' are impacting the job satisfaction of ECRs and potentially compromising science in Australia. We also make recommendations for addressing some of these concerns.

KATHERINE CHRISTIAN *, CAROLYN JOHNSTONE, JO-ANN LARKINS, WENDY WRIGHT AND MICHAEL R DORAN *

Introduction

Advances in science, technology, engineering, mathematics and medicine (STEMM) have revolutionized virtually every facet of modern life. In Australia the government is relying on further advances in these fields to underpin future economic prosperity (Innovation and Australian Government, 2017). Australia has also become the largest provider of education to international students in the Organization for Economic Co-operation and Development (OECD) nations (Sá and Sabzalieva, 2018), with a rise in the number of PhD students accounting for a large portion of this increase: indeed, the number of students (domestic and international) completing a PhD in 2019 was more than twice the number for 2000 (McCarthy and Wienk, 2019).

Two international surveys conducted in 2015 (Ghaffarzadegan et al., 2015) and 2017 (Woolston, 2017) indicated that nearly 78% and 75% of PhD candidates, respectively, aspired to obtain a job in academia, despite the global lack of such job opportunities. Not all PhD graduates need work in academia, but the advanced industries that typically employ highly skilled workers are less developed in Australia than, say, the United States or Germany (Christopherson et al., 2014; Weller and O'Neill, 2014). Australian graduates are therefore more dependent on academia as an employer than graduates from other OECD nations. A previous survey of 284 postdoctoral researchers in Australia revealed that more than half (52%) took their position hoping to transition to a full-time research role in academia (Hardy et al., 2016). The majority of respondents (54%) felt that structural, rather than personal limitations would prevent them from realizing a long-term research career. In addition to concerns about the international so-called 'glut' of PhD students (Woolston, 2017; Woolston, 2014; Woolston, 2019) there have been concerns about the reproducibility of published findings in a number of research areas (Baker, 2016; Begley and Ellis, 2012).

Early-career researchers (ECRs) represent the transition stage between PhD and senior academic positions, and their well-being provides insight into the health of the industry. In this study, we surveyed ECRs in STEMM disciplines in Australia to better understand the pressures impacting them and their career development. We defined ECRs as being less than 10 years since PhD completion, similar to the definition used by the Global Young Academy in their study of how to best support young scientists on a global scale, and another important survey of the STEMM workforce conducted in Australia

*For correspondence: katherinechristian@students.federation.edu.au (KC); michael.doran@qut.edu.au (MRD)

Competing interests: The authors declare that no competing interests exist.

Funding: See page 17

Reviewing editor: Julia Deathridge, eLife, United Kingdom

(Pain, 2014; Bell and Yates, 2015). Data were collected from respondents employed in research institutions or universities via an on-line survey (n = 658), which was developed based on previously published questions and through focus group discussions (Supplementary file 1). From our survey we quantified job satisfaction, likelihood of continuing to work in research in Australia, views on mentoring and career planning, and observation of questionable research practices (see material and methods for more detail on how topics were selected for the survey).

In addition to fraud, John et al., popularised the notion that questionable research practices included less egregious practices, such as data exclusion, may in fact be more prevalent and more damaging to the academic enterprise (John et al., 2012). Their findings warned that the frequency of questionable practices may be so prolific that they are becoming 'the norm' in research. Note that we did not define 'questionable research practices' in our survey. However, our data suggests that the systemic pressures compromising the training and career progression of ECRs in Australia may also contribute to a decline in research quality. It is time to carefully consider if the support and career advancement options available to ECRs in STEMM subjects is aligned with Australia's scientific aspirations. As many of the documented pressures highlighted in this study are common global problems, these data likely highlight important considerations relevant to the international research community.

Results

Demographic of respondents

Of the 658 respondents, 65.8% identified as female and 34.2% as male. The two most common age brackets were 31–35 years old (42.7%) and 36–40 years old (25.9%), with most respondents having completed their PhD 2–4 years earlier (37.8%) or 5–7 years earlier (25.3%). The four most common countries of birth were Australia (50.6%), England (6.2%), India (4%) and China (2.5%). Of the respondents, 48% identified as being in the medical and health sciences and most (63.2%) were employed in a research only position. Recent data from the Australian Research Council (ARC) indicates that 38.9% of Australia's STEMM workforce is employed in the medical and health sciences (Table 1; Australian Research Council, 2019). Comparison of our survey demographics with this ARC data indicates that our sample and the target population were not statistically different by discipline (chi square = 16.344, df = 9, p=0.06), and our survey population can be considered representative. A more detailed summary of respondent demographics is provided in Figure 1.

Table 1. Distribution of research disciplines in STEMM.

The percentage of academics in Australia that work in different STEMM disciplines, relative to the percentage of survey respondents in each discipline (n = 658). **Australian work force data sourced from Australian Research Council, 2019.

Discipline	**Percentage of Australian academic STEMM workforce	Percentage of respondents to this survey
Mathematical Sciences	3.8%	2.8%
Physical Sciences	4.3%	8.1%
Chemical Sciences	4.7%	5.7%
Earth Sciences	3.5%	3.0%
Environmental Sciences	3.2%	4.0%
Biological Sciences	12.6%	20.9%
Agricultural and Veterinary Sciences	4.5%	1.4%
Information and Computing Sciences	6.9%	2.2%
Engineering	15.4%	3.6%
Technology	2.1%	0.8%
Medical and Health Sciences	38.9%	47.5%

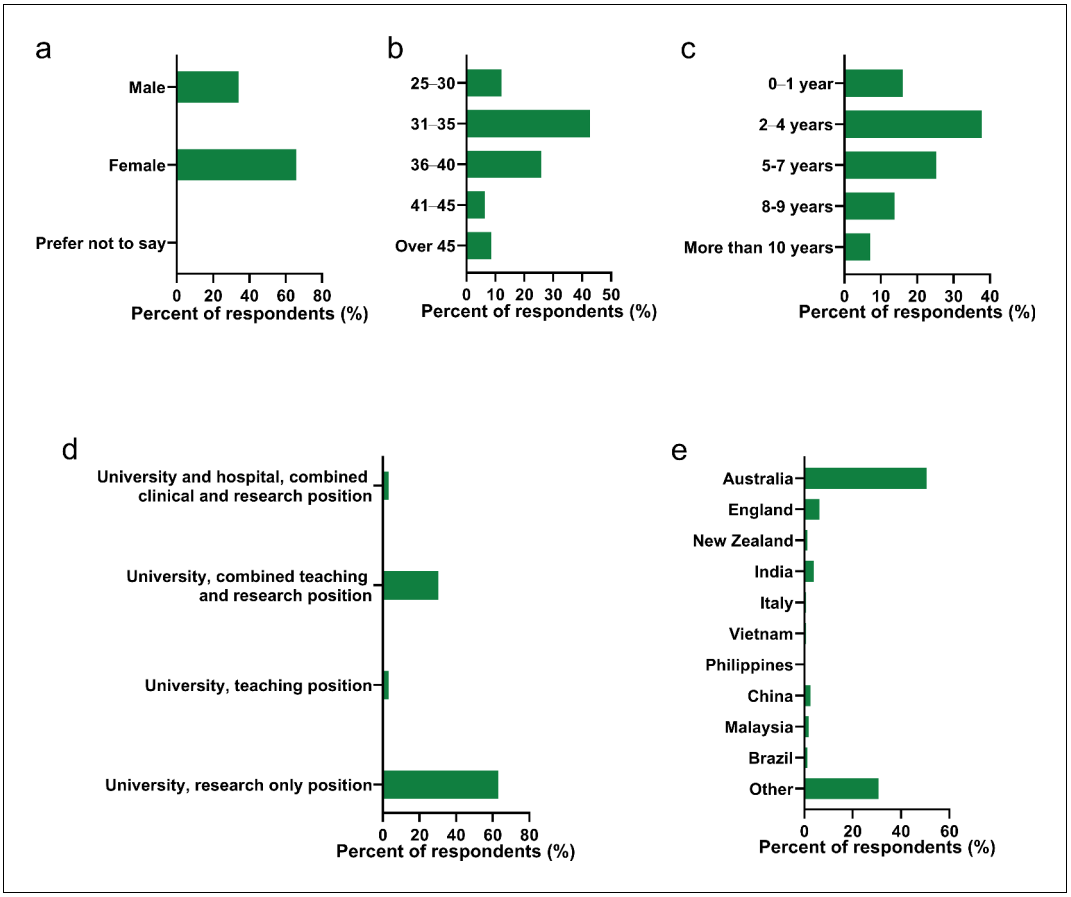


Figure 1. Demographic data of survey respondents. (a) Gender of respondent n = 658. (b) Age of respondent n = 660. (c) Years since completion of PhD n = 833 (ineligible respondents subsequently terminated). (d) Nature of employment n = 638 (does not include 'other'). (e) Country of birth n = 658.

Characteristics that influence ECR job satisfaction

We attempted to identify workplace characteristics that influenced ECR job satisfaction and career progression. Using a non-biased approach, we used text responses to generate a word cloud (Figure 2), and tabulated the most common words associated with satisfaction or dissatisfaction in the context of the responses to survey question 76 (Why do you stay?). Respondents almost universally noted their 'love' of research and the job fulfilment it provides (Figure 2—source data 1 and Table 2). ECRs reported that they derived fulfilment from research, mentoring, teaching and the general sense that they are making a meaningful contribution to society, while job security and challenges associated with the job remain major concerns (Table 2). One respondent said, 'I love it! I am passionate about my work and driven to make a difference. I will keep going as long as I can'.

Satisfaction with workplace culture and intention to leave academia

We queried ECRs regarding satisfaction with their workplace culture. Academic workplace culture, which encompasses interactions between colleagues and professional norms (Faulkner, 2009), has evolved with corporate pursuits and hypercompetitive funding environments (Edwards and Roy, 2017). Figure 3 shows that 51.0% of respondents indicated that they were satisfied or very satisfied with their workplace culture, while a concerning 31.9% were somewhat or very dissatisfied with their workplace culture. Overall, the survey data indicated that the most significant barrier to job satisfaction and career advancement was job insecurity (48.9%). A poor workplace culture (31.9% dissatisfied or very dissatisfied), lack of support from institutional superiors (60.1% a problem or significant problem), poor leadership and management (33.1% dissatisfied or very dissatisfied), and lack of recognition (22.6%

Figure 2. Why respondents stay in research. Word cloud of the responses to survey question number 76 (Why do they stay in science?). The analysis tool NVivo v12 for Mac was used to count the frequency of words in the answers. Of the 334 answers, 108 mentioned love, 16 mentioned passionate and 11 mentioned passion (see Figure 2—source data 1).

The online version of this article includes the following source data for figure 2:

Source data 1. These data were generated from the open ended responsed to question 76: Why do you choose to stay in science?

disagree or strongly disagree they feel valued) and lack of work life balance (38.1% disagree or strongly disagree they can manage the demands of work and home life) were further major influences compromising satisfaction. When respondents positively described job satisfaction, this was associated with responses indicating good leadership and management (47.3% were satisfied or very satisfied), feeling valued (61.9% agree or strongly agree they feel valued) and confidence in job prospects (35% agree or strongly agree they have good job prospects).

Some respondents indicated that attitudes to their gender (13.1% reported a problem or major problem), ethnic background (5.8%) or sexual orientation (1.4%) may have impacted their career advancement. However, when we made detailed queries regarding workplace challenges detailed in Question 36, we observed effectively no significant difference in the responses from male or female researchers, nor from researchers who were Australian born or non-Australian born. We were unable to draw conclusions regarding the impact sexual orientation might have on workplace challenges, as we did not ask respondents to identify their sexual orientation other than with respect to their living arrangements.

Table 2. Selected responses to the question: Why do you choose to stay in science? (question 76 in our survey).
Quotes were selected as they conveyed respondents' love of science. In addition to the positive responses shown here, respondents also expressed concerns about job security, mentorship and workplace culture.

Quote number	Specific response
1	I love figuring stuff out. I love inventing new ways to measure stuff.
2	I love it! I am passionate about my work and driven to make a difference. I will keep going as long as I can.
3	I love my job - it doesn't feel like a job - I get to do what I enjoy. That said, the lack of job security and the challenges of having a family, buying a house and staying in the one city in Australia makes it difficult to imagine remaining in research/academia.
4	I love my job, being able to develop new research questions and work with clinicians and patients. But I do not love the industry. The lack of job security, challenges in supporting a team, and constant pressure to do more as soon as you can is deeply problematic.
5	I love research and discovery, a core part of my identity is 'scientist'. I'm not sure who I would be outside academia.
6	I love research and I love teaching, and academia offers the opportunity for both of these. Improved job security would be the one key thing to improve my experience.
7	I love research and my research area, I want to help people through my science discoveries and the sharing of these results.
8	I love research! No two days are the same and it is extremely rewarding. You have to celebrate the few good days you have (manuscript accepted, award at a conference, grant etc.). The opportunity to truly make a difference to the lives of people is what keeps me going!

Those who were more than 4 years post-PhD were less likely to be satisfied with their job (55.7%) compared to those who were 4 years or less post-PhD (66.9%). Similarly, those who were more than 4 years post-PhD tended to indicate a higher frequency of being negatively impacted by lack of support from institutional supervisors (increase of 13.4%), questionable research practices of colleagues within their institution (increase of 14.5%), and harassment based on power position (increase of 5.6%). In addition, less than 40% express satisfaction with leadership and management in their workplace compared to 53.4% of respondents who are less than 4 years post-PhD. In responses to Question 74–1 'This is a poor time for any young person to begin an academic career in my field', more senior postdoctoral researchers indicated that this was not a good time to be in science, and were less willing to recommend science as a career (73.2% compared to 58.5% of junior researchers).

We compared our survey respondents' satisfaction data with previous survey data from academics in Australia (Supplementary file 2; Bell and Yates, 2015; Coates et al., 2009; Bexley et al., 2011; NTEU State of the Uni Survey, 2017). Each of these studies used one or more of the 'job satisfaction' questions from our survey in their own survey of the academic workforce in Australia. It can be seen respondents from the current study are more concerned about job security than respondents in any of the other studies. Our respondents also indicated a higher level of personal stress (52%) than those in all the other studies (28%–43%) and agree most strongly (65%) 'this is not a good time for any young person to aspire to an academic career'. Their reported job satisfaction is low (62%). The combination of answers to these questions for current ECRs relative to those for the other studies indicates a situation about which there should be grave concern.

Previous studies have identified diversity and inclusion as factors that have impact on senior academics' dissatisfaction (Zimmerman et al., 2016; Professionals Australia, 2014), including the career progression for female academics (Potvin et al., 2018; Else, 2019; Gewin, 2018). However, in our survey of ECRs working in Australia, most identified as satisfied or at least unconcerned, regarding discrimination with respect to age (87.2% satisfied or not concerned), gender (85.9% satisfied or not concerned), ethnic background (93.8% satisfied or not concerned) or sexual orientation (98.2% satisfied or not concerned). Low levels of concern regarding attitude to ethnicity could reflect an under-representation of respondents from minority backgrounds. Similarly, low rates of reported concern about attitudes to sexual orientation may reflect the small number of respondents (3%) who identified as living with a same sex partner.

When asked to what extent they agreed with the statement 'I am satisfied with my workplace's commitment to a diverse and inclusive workplace', 6.4% strongly disagreed, 11.5% disagreed, 20% neither agreed or disagreed, 41.2% agreed and 21% strongly agreed. Gender did not appear to influence ECR's perception of their workplace, with satisfaction rates being

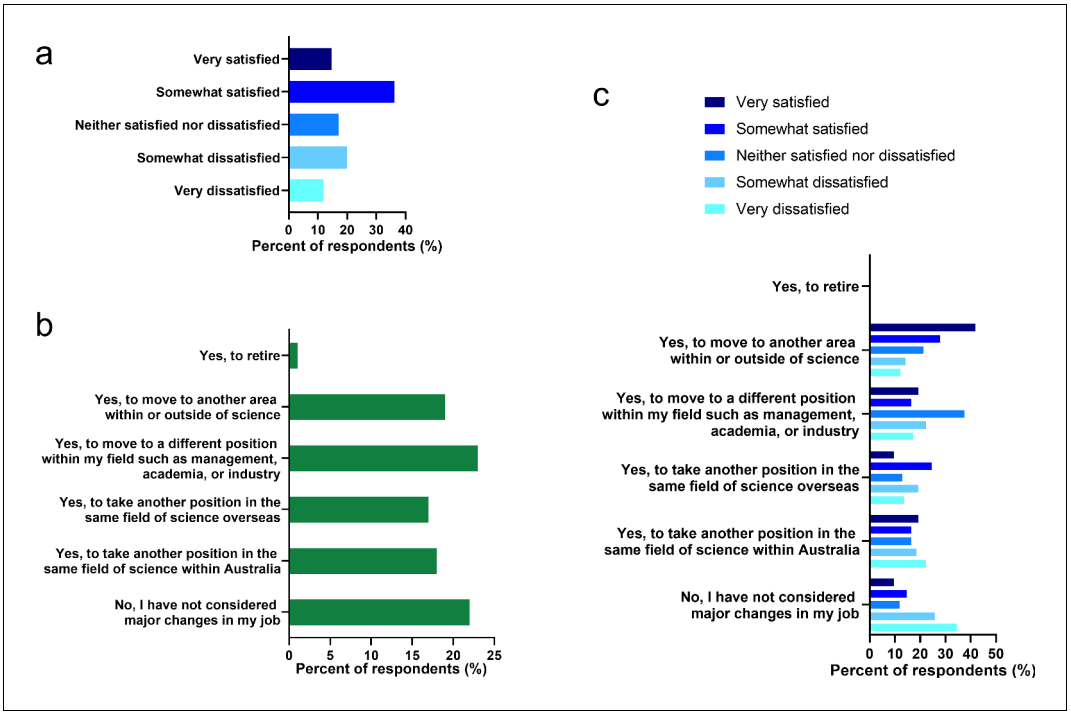


Figure 3. Job satisfaction does not influence the decision to make a major career change. (a) Respondents were asked to rate their overall satisfaction with their current work (Question 31–4 in survey, n = 566). (b) Respondents were asked if within the last five years they had considered any major career or position changes, and what these might be (Question 61 in survey, n = 470). (c) For those considering a major career or position change in the previous 5 years, we stratified responses from respondents based on satisfaction with their current position (n = 470).

The online version of this article includes the following figure supplement(s) for figure 3:

Figure supplement 1. Satisfaction with workplace culture stratified by gender and country of birth.

similar between male and female respondents (50.3% satisfied or very satisfied versus 51.9%, Figure 3—figure supplement 1A). However, workplace position did influence satisfaction rates, with those on teaching only positions reporting the highest levels of satisfaction (23.1%), and none reporting being very dissatisfied (Figure 3—figure supplement 1B). Those in research and teaching positions reported high levels of dissatisfaction (25.4% somewhat dissatisfied and 12.7% very dissatisfied).

We did not identify an obvious influence on country of birth on job satisfaction (Table 3 and Figure 3—figure supplement 1C). Both Australian and non-Australian born researchers reported finding their work rewarding (78.0% and 76.4%), were satisfied or very satisfied with their current job (65.2% and 59.5%), but also categorised their job as a considerable source of personal strain (56.2% and 45.9%) and indicated a lack of support from institutional supervisors (63.5% and 55.6%). We regard the consistency in reporting as not necessarily indicating that country of birth has no impact on job satisfaction, but rather that systemic workplace culture issues dominate the concerns of both Australian and non-Australian born researchers.

We asked if ECRs had considered a major career or position change in the previous 5 years. The majority (78.3%) of respondents had considered a major career change, while only 21.7% had not (Figure 3B). Many considered leaving academia all together (19.1%) or moving overseas (17.4%) in order to progress their career path. For each group of respondents that indicated that they had considered a major career change, we quantified how satisfied they were with their current work environment (Figure 3C). Interestingly, within the population of ECRs who had not considered a career change, the largest group (34.5%) were dissatisfied with their current workplace. By contrast, within the population of ECRs who indicated that they had recently considered moving to another area within or outside of science, the largest group (41.9%) were very satisfied with

Table 3. How does country of origin influence job satisfaction?

Table shows the percentage of respondents born in Australia and born outside Australia who agreed with the following statements (under Question Detail) about their job satisfaction.

Question detail	Australian born	N	Not born in Australia	N	All
I am satisfied with the attitude to people of my ethnicity	48.7%	263	44.2%	249	46.4%
Overall, I find my work rewarding	78.0%	287	76.4%	271	77.2%
I am satisfied with the culture of my workplace	53.0%	287	49.3%	270	51.0%
I have been impacted by harassment based on power position	32.7%	263	34.4%	249	33.5%
I have been impacted by lack of support from institutional supervisors	63.5%	263	55.6%	247	59.8%
I have been impacted by questionable research practices of colleagues within my institution	36.1%	263	39.7%	247	37.1%
I am satisfied with the leadership and management of my workplace	48.8%	287	45.9%	270	47.1%
My job is a source of considerable personal strain	56.2%	242	45.9%	220	51.6%
How would you rate your overall satisfaction with your current job (satisfied or very satisfied)	65.2%	242	59.5%	220	62.3%

their current workplace. These data suggest that there might be populations of ECRs who are unhappy in their current workplace, but feel trapped, while there is another population of ECRs who are very happy in their current workplace, but feel changing jobs would be beneficial. More generally, ECR's satisfaction with their current position does not appear to significantly bias their consideration of major career changes.

Influence of gender, country of origin and appointment type on workplace challenges

Workplace and career progression challenges are displayed in Table 4. Data were sorted based on gender and subsequently sorted based on appointment types, which were categorized as 'research only', 'research and teaching', or 'clinician researcher'. Those with a teaching or clinical appointment are likely to be less dependent on research funds for their salary, and thus their perspectives may differ. Greater than 50% of both male (52.4%) and female (63.8%) ECRs indicated that they felt they had been negatively impacted by a lack of support from institutional leaders (Table 4A). Female ECRs indicated higher rates of inequitable hiring practices (40.0% females versus 35.4% males) and harassment from those in a position of power (31.7% females versus 25.9% males). Interviews with ECRs conducted in another part of this project and the focus group which evaluated the questionnaire for this survey, as well as survey responses, suggest instances where senior academics (both male and female) were regarded as bullies (the results of this part of the project will appear in a separate publication). When asked if they feel safe in the work environment, overall 12.5% felt unsafe with an unexpected bias of males (15.6%) to females (11.0%) reporting this problem (Table 4A). We further delineated these data based on researchers who were either Australian or non-Australian born, finding that non-Australian born researchers reported being marginally less safe at work (15.1%) than respondents born in Australia (10.1%). Similarly, slightly more non-Australian born researchers reported inequitable hiring practices being a significant problem in their career advancement (14.5% versus 11.8%).

Impact of inappropriate behaviours

Particularly concerning was the number of female and male ECRs who identified that their wellbeing, or their career had been impacted by questionable research practices within their institution (41.4% of females and 30.7% of males) or external to their institution (33.6% of females and 28.9% of males). While some respondents would have been cautious not to reveal specifics regarding questionable research practices, even in a confidential survey, a number of comments did provide reasonably detailed examples of concerning behaviour (Table 5): '. . .what they wanted to see result-wise wasn't what I was seeing. And so, I was being accused of misconduct because I wasn't seeing what they wanted me to see, and I wouldn't change that'.

When the data was re-sorted based on appointment type, it was possible to estimate the influence that different appointments and contract stability may have on ECR job satisfaction and/or career progression (Table 4B). The majority of clinician researchers (79.0%) reported having been impacted by lack of support from

Table 4. How gender and academic position affect job satisfaction and career advancement.

(A) Factors that impacted ECR job satisfaction and/or career progression, analysed with respect to gender (n = 511). (B) Factors that impacted on ECR job satisfaction and/or career progression, analysed with respect to ECR appointment type (n = 509). Teaching only (20) and 'Other' (62) responses are omitted from (B).

(A)

Workplace characteristic	Female (n = 345)			Male (n = 166)		
	Impacted	Strongly impacted	Total impacted	Impacted	Strongly impacted	Total
Lack of support from institutional superiors	45.5%	18.3%	63.8%	34.3%	18.1%	52.4%
Inequitable hiring practices	27.8%	12.2%	40.0%	19.8%	15.6%	35.4%
Harassment based on power position	25.4%	11.6%	37.1%	14.5%	11.4%	25.9%
Questionable research practices of colleagues within their institution	34.2%	7.2%	41.4%	18.7%	12.0%	30.7%
Questionable research practices outside their institution	27.2%	6.4%	33.6%	21.7%	7.2%	28.9%
Feeling unsafe in the work environment	4.3%	6.7%	11.0%	7.0%	8.6%	15.6%

(B)

Workplace characteristic	Research only (n = 282)			Research and teaching (n = 126)			Clinician researcher (n = 19)		
	Impacted	Strongly impacted	Total	Impacted	Strongly impacted	Total	Impacted	Strongly impacted	Total
Lack of support from institutional superiors	37.4%	17.1%	54.5%	42.1%	22.2%	64.3%	63.2%	15.8%	79.0%
Inequitable hiring practices	23.8%	9.6%	33.4%	26.2%	20.6%	46.8%	42.1%	10.5%	52.6%
Harassment based on power position	20.3%	11.4%	31.7%	27.0%	14.3%	41.3%	15.8%	10.5%	26.3%
Questionable research practices of colleagues within their institution	27.0%	10.3%	37.3%	27.8%	6.3%	34.1%	26.3%	10.5%	36.8%
Questionable research practices outside their institution	25.3%	8.5%	33.8%	23.8%	4.0%	27.8%	21.1%	15.8%	36.9%
Feeling unsafe in the work environment	8.4%	4.2%	12.6%	6.7%	7.4%	14.1%	5.0%	5.0%	10.0%

institutional superiors, compared with research and teaching ECRs (64.3%), and research only ECRs (54.5%). This pattern was replicated with respect to inequitable hiring practices reported more frequently by clinician researchers (52.6%), followed by research and teaching ECRs (46.8%), and research only ECRs (33.4%). These data may indicate that ECRs employed across multiple research, teaching and clinical departments struggle more to find unified institutional support, or to access what they perceive to be equitable hiring/recruitment practices. While clinician researchers we surveyed faced a number of challenges, we note that our survey only captured data from 19 such respondents. These ECRs, in many cases, rely primarily on their clinical appointment as a source of income, and so are potentially less sensitive to job insecurities felt by research only ECRs. Only two (10%) of clinician researcher ECRs reported feeling unsafe at work, compared with 39 (12.6%) research only ECRs, and 19 (14.1%) research and teaching ECRs. Similarly, clinician researchers reported less impact of harassment based on power positions (26.3%), compared to research only (31.7%) and research and teaching ECRs (41.3%). It is possible that the job security benefits realised by clinician researchers manifests itself in actual or perceived reductions in feeling unsafe at work, and reduced harassment from those in a position of power.

The frequency that questionable research practices had negatively impacted ECRs declined incrementally from those who were research-only (37.3% internally and 33.8% externally), clinician researchers (36.8% internally and 36.9% externally) and research and teaching (34.1% internally and 27.8% externally). These data suggest that greater research time commitment may increase the frequency of exposure to questionable research practices, but that the stability associated with salary funding from a teaching or clinical position does not obscure the perception that this is a major problem.

Table 5. Quotes regarding questionable research practices (from surveys and interviews).

Quote number	Specific response
1	. . ..the bullying and stuff came to a head and the scientific work was looked at because this person had brought up kind of bullying and harassment allegations against the supervisor. So they in turn looked at the work that this person had been doing and they'd been falsifying. . .
2	Lack of funding and the need to 'sell' your research, often leads to many researchers fabricating and embellishing data. This leads to the inability of genuine researchers to replicate findings, wasting precious time and resources, giving up and then their contracts not being renewed because the boss doesn't get the 10 publications per year they demand.
3	I believe that the whole Academia environment is corrupted and has lost its true vision. The lack of funding is making researchers to sometimes make-up data to get grants or to publish meaningless papers just for the sake of raising the numbers.
4	being used by post docs and high level senior researchers' who take credit for your research work ideas and use info in your recruitment applications unethically for themselves. . .bias recruitment towards international students and overseas post docs who are extremely competitive and who want to get permanent residency and who also bully harass local students and researchers' to take over their research and jobs.
5	. . .what they wanted to see result-wise wasn't what I was seeing. And so I was being accused of misconduct because I wasn't seeing what they wanted me to see, and I wouldn't change that.
6	Not saying, 'do this' but pressure to – if something were to fail to almost keep saying, 'Do it again, do it again, do it again, do it again'' in order to get you to make it work. And those people have just said, 'No, it doesn't and I'll spend the whole year repeating it but it's not going to change the outcome'.
7	Q But are they getting their names on because they've actually been involved? Are we flouting the convention here? A They haven't done anything. Q So his investment in them is. . . A Is purely so they can get grant funding through having papers.

The need to relocate

Many academics relocate to capture job opportunities, and many appreciate the opportunity to move internationally with their career. However, we observed that the academic culture promotes a perceived need to relocate during the ECR years, and that many ECRs who wished to remain in academia considered moving as part of their career development process. To better understand this phenomenon, we asked more detailed questions regarding decisions to move. The answers to these questions indicated that moves to new institutions can be stressful, are frequently made without financial compensation, and can be challenging for families and for careers (Table 6).

This problem was highlighted in recent article published in Science, which described the struggles of a tenure-track academic on a work visa in the United States who was unable to gain financial approval to purchase a home (Evaristo, 2020). While a tenure-track academic can make long-term decisions, this is virtually impossible for many ECRs. Most (68.1%) respondents reported that they had already changed location in order to advance their careers. Of these, 28.6% of ECRs had moved once, 20.1% had moved twice and 19.5% had moved more than twice. Commonly expressed consequences, noted in interviews and in text-based responses, were that relocation was associated with stress, separations from family, loss of support network, personal cost and loss of career momentum. Within the small number of respondents that reported a chronic health condition (12%) some indicated that relocation was challenging.

Mentorship and career guidance

To better understand ECRs concerns regarding support from institutional leaders, respondents were asked to describe their mentorship and career guidance. A definition of a of mentor was provided with the questions: "A mentor is someone who is there to assist you achieve your personal, academic and career exploration goals. This person is not necessarily your supervisor'. In our survey, 61.9% of ECRs reported having a mentor, while 38.1% did not. We asked ECRs to indicate what aspects of mentoring they valued most, and these data are summarized in Figure 4A. ECRs valued advice on career decisions (81.7%) as the most important contribution from mentors. This was followed by integration into networks (77.2%), and direct influence on their gaining employment (56.7%). Ranked less significant, but still important, were skill training on methodologies (60.3%), fundraising (50.8%), and scientific writing (59.7%). Of those with a mentor, the quality of the mentoring was often described as inadequate, and some indicated that they paid for external mentoring. From the survey data (n = 322), those who did receive

Table 6. Quotes regarding the stress of relocation.

Quote number	Specific response
1	The most significant impact has been on my productivity for the few months after I move. Settling into a new environment takes time. I had little to no support to find accommodation[sic], so much of my time was spent on this. The mental/emotional drain of a move is also significant.
2	Starting from scratch with a whole new group of colleagues who don't know you and struggling to find research momentum in a new institute, city and country, all of which is very different to previous places you've lived before. Everything is done differently and you're constantly learning the hard way, which takes time and significantly eats into your research progress. It's also lonely and can inhibit the development of long-lasting professional and personal relationships because you have no idea how long you'll really be in the country.
3	Lack of stability, no ability to build long term friendships and networks, relationship breakdowns, financial costs, inability to buy a house.
4	Loss of traction and momentum in science. Loss of family and friend support. Starting life from scratch. Financial loss from moving costs, to higher rents in locations I moved to.
5	Relocation meant my partner having to give up her job
6	Separation from family and friends, impact on spouse's career, new start at new institutions take time and are somewhat unproductive.
7	Moving internationally with a young family has been extremely difficult. Lack of family support with both myself and husband working full time is extremely difficult to manage.
8	Moving to further career progression - like an international fellowship visit - should not be applicable to all fields of research. Furthermore in families with two working adults this is unrealistic and archaic. There are other options to building an international reputation. I moved internationally to complete my PhD.

mentoring (Question 44 of our survey) described it as follows; 15.1% neutral, 7.5% not beneficial, 32.8% highly beneficial, or 44.6% beneficial.

With respect to supervision, as opposed to mentoring, only 68.3% of respondents had a performance review in the past two years, indicating that 31.7% had not. While half of the 31.7% respondents with no performance review indicated that they had recently been appointed or were on probation (not unusual in an environment where short term contracts are commonplace), the other half had not been offered a review. Many who did have a performance review did not find the process useful (41.6%; Figure 4B). There was no opportunity given to provide an explanation for these answers, however, respondents identified the primary utility of performance reviews as being (1) a review of personal progress (57.1%), (2) identifying strengths and achievements (50.7%), (3) help focusing on career aspirations (50.4%), and (4) to highlight issues (44.2%). ECRs identified performance reviews as least useful in leading to changes in their work practices. Given that performance reviews are often used to influence work practices, it is useful to know that this process is frequently viewed as ineffective.

Intention to leave

Finally, we circled back and considered if the positions ECRs held were similar to what they had anticipated, and if they intended to remain in or leave these positions (Figure 5A). Relatively few (14.5%) found their current position to better or much better than expected. Regardless of their perception of the position, many ECRs indicated their intention to leave. There was a trend (regression analysis, p=0.0234) indicating a greater bias to leave the position depending on how it had met expectations (Figure 5B). However, even in instances where the current position was much better than expected, nearly 40% more (61.5%) ECRs intended to leave the position rather than remain (38.5%).

As most ECR positions are short-term contracts, including those supported by 'soft money' (where all expenses for that researcher, including salary, are covered by fixed-term grants), it might be rational to expect to have to leave a position even if the position had met or exceeded expectations. If ECRs were to leave their current academic position, we asked what the primary motivation would be (Figure 5C). Cumulatively, two of the possible responses, lack of funding (28.2%) and job insecurity (48.9%), accounted for 77% of likely motivations for ECRs leaving their current position. Establishing an independent research group is the goal of many ECRs. Lack of independent positions was cited as the motivation 11.8% of ECRs would use to justify leaving their current position. While in Table 5 many respondents list poor institutional support as problematic, only 1.4% of respondents cite interpersonal relationships with their supervisor as a potential motivation for leaving their current position. We found that family/carer responsibilities were cited by

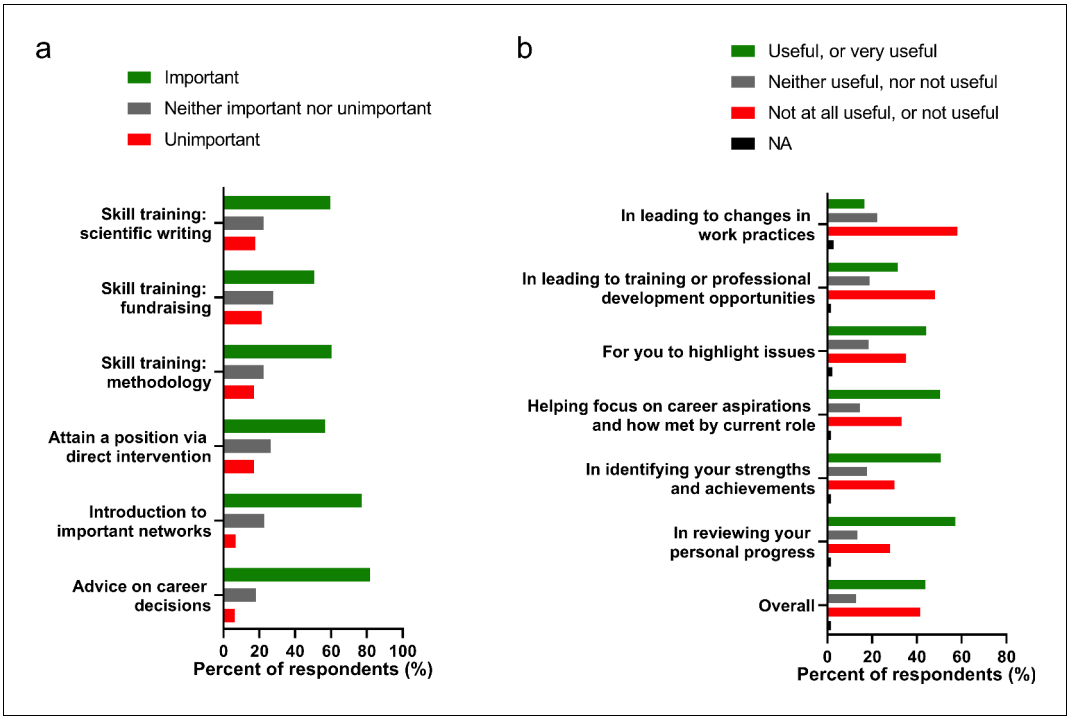


Figure 4. Aspects of mentoring that are the most and least important to ECRs. (a) We asked respondents to indicate how much value they placed on different aspects of mentoring from more senior colleagues (n = 481 respondents). (b) We asked respondents who had participated in staff performance reviews to indicate which aspects of the review process they valued (n = 322 respondents who received a review).

9.6% of ECRs as a reason to exit academia. Similar to a previous survey of postdoctoral researchers in Australia, the burden of family/carer responsibilities is heavy on both male and female ECRs, suggesting that young parents (male or female) and their families are not sufficiently accommodated by the current system. In interviews, we did identify young mothers on parental leave struggled to continue to run their laboratories, knowing that their staff depend on them, and continued to write publications while on leave out of fear of falling behind. Quotes in Table 7 provide insights into stresses felt by ECRs in Australia; we leave the comments to speak for themselves.

Given the many challenges faced by ECRs, their persistence in their endeavours to remain in the academic research workforce is impressive. However, their perceived commitment to academia in Australia may be confounded by limited number of alternative (perceived and actual) employment opportunities outside of academia. A number of comments made by ECRs (Table 8), indicate that they consider themselves to be inadequately trained for alternative careers, that there are limited alternatives available, or that they regard leaving academia as a failure. One respondent said, 'I constantly think about leaving academia/research (from necessity not choice) but don't know how and am not qualified for any other jobs.'

Discussion

It is common vernacular to say that 'ECRs are the future'. If this is factually true, then are we content with how we are shaping this future? We suggest that this survey data provides reason to be concerned. While ECRs in our survey overwhelmingly and repeatedly indicated that they 'loved' their work, only 51.0% of ECRs indicated that they were satisfied with their workplace culture. More than half of ECRs felt they had been negatively impacted by a lack of support from institutional leaders. This is in agreement with previous studies which showed that academics loved their work and realised intellectual satisfaction, but were frequently discontented with their own institution and wonder if they would be happier somewhere else, in a different profession or industry (Johnsrud and Rosser, 2002; Smith, 2020).

Many ECRs in our survey indicated that they did not have a mentor (38.1%), nor performance review (31.7%). Superficially, these data suggest

Table 7. Quotes regarding stresses in the current system (explanations offered for responses to Question 73).

Quote number	Specific response
1	I just find the other aspects of the job and the pressure to perform very difficult. I feel like there is a big clock ticking, and my productivity is always being judged relative to the steady ticking of that clock regardless of the ups and downs and other life circumstances.
2	I just wish that the environment didn't feel so pressured and competitive. I have seen so many great ECRs leave research because of the challenges of finding work, meeting expectation, attracting grants. I think the field is too competitive and does not take care of our ECRs and we are poorer for it.
3	I am currently looking outside academia to get away from the culture of harassment... it takes too much of a toll on my health... but I would stay in academia if I were to find a position that didn't subject me to harassment by a supervisor.
4	Job security is based on churning out a large quantity of publications, regardless of quality. Three-year fixed-term contracts are very short. In the first 2 years, I focus on my research, however, in my final year, I am thinking about where I am going next. It takes a lot of time and effort to find something else within the research field. I find having an 'exit strategy' important.
5	Having said that, the pressures of the job have considerably increased in the last ten years and the general expectation is that you should work outside normal working hours, without getting paid extra... And that being able to work in academia is a privilege, so one should do whatever it takes to continue in Academia. In my opinion this is a very distorted and dangerous vision, which puts lots of pressure on ECRs, in particular women who are usually starting families at this stage in their careers.
6	At the point of my career, where I am trying to expand my group to potentially have an independent research group, the stresses around funding are a considerable issue for me (as for everyone else, probably). While I have been relatively successful with funding, I feel the pressure of having to support not only my own research, but also the research of those who work with me, and that holds me back from pursuing opportunities that are available to me as I don't want my group to expand too quickly. It also means that I put up with being paid on a lower pay scale than I should be, rather than going for promotion, because I want to conserve funding. This is certainly a constraint on my ability to expand my career prospects.
7	The personal toll it takes to have an academic position is immense. The job insecurity, being unable to plan for anything beyond 1-maybe 2 years is debilitating. Constantly responding to this opportunity, and that opportunity, doing good clever work and being available at all times is tough beyond measure. Not knowing if all this personal sacrifice and tough hard work are even going to be worth it is downright demoralizing. It might all work out, and it might not - but when do you pull the pin??
8	Mental health of ECRs is overlooked and the universities treat us as second class employees that are disposable.

that allocation of a mentor and performance review would lead to considerable improvements. However, a number of respondents (41.6%) indicated that they did not find the performance review useful. When mentoring and reviews were provided, ECRs valued career advice most, followed introduction to important networks, and the capacity of their mentor to directly help them find employment. Ranked less significant, but still important, were skill training on methodologies, fundraising, and scientific writing. These preferences may seem surprising, but a previous survey of postgraduate researchers in Australia found that the quality of supervision did not positively influence initial job attainment, but that 'nurturing networking and careers advice' did (Jackson and Michelson, 2015). This pattern may remain robust among STEMM ECRs in Australia, where 'who you know' could play a significant role in employment outcomes. Our data suggest that ECRs believe this is a factor, and many report being impacted by inequitable hiring practices (40.0%, females and 35.4%, males). Job stress in the sector is likely causing similar patterns to evolve in jurisdictions around the world (see discussion on social networks and so call 'gate keepers') and academic recruitment (van den Brink and Benschop, 2014).

We do not dismiss the value of good mentoring and recommend that group leaders consider investing time into training and mentoring strategies (see, for example, Lee et al., 2007). It was reported recently that ECRs who co-author publications with highly-cited scientists have greater probability of repeatedly co-authoring additional publications with top-cited scientists, and, ultimately, a higher probability of becoming top-cited scientist themselves (Li et al., 2019). While this does not directly constitute mentorship, it does provide an indication of the value of being able to follow or mimic an established research leader.

We consider the most concerning of all of our results to be the high rate at which ECRs (41.4% of females and 30.7% of males) claimed that questionable research practices within their institutions had negatively impacted their careers. We did not define 'questionable research practices' in our survey, but this terminology is commonly used to describe activities ranging from fraud to less egregious practices, such as data exclusion or p-Hacking (John et al., 2012). A 2019 survey conducted by the National Health

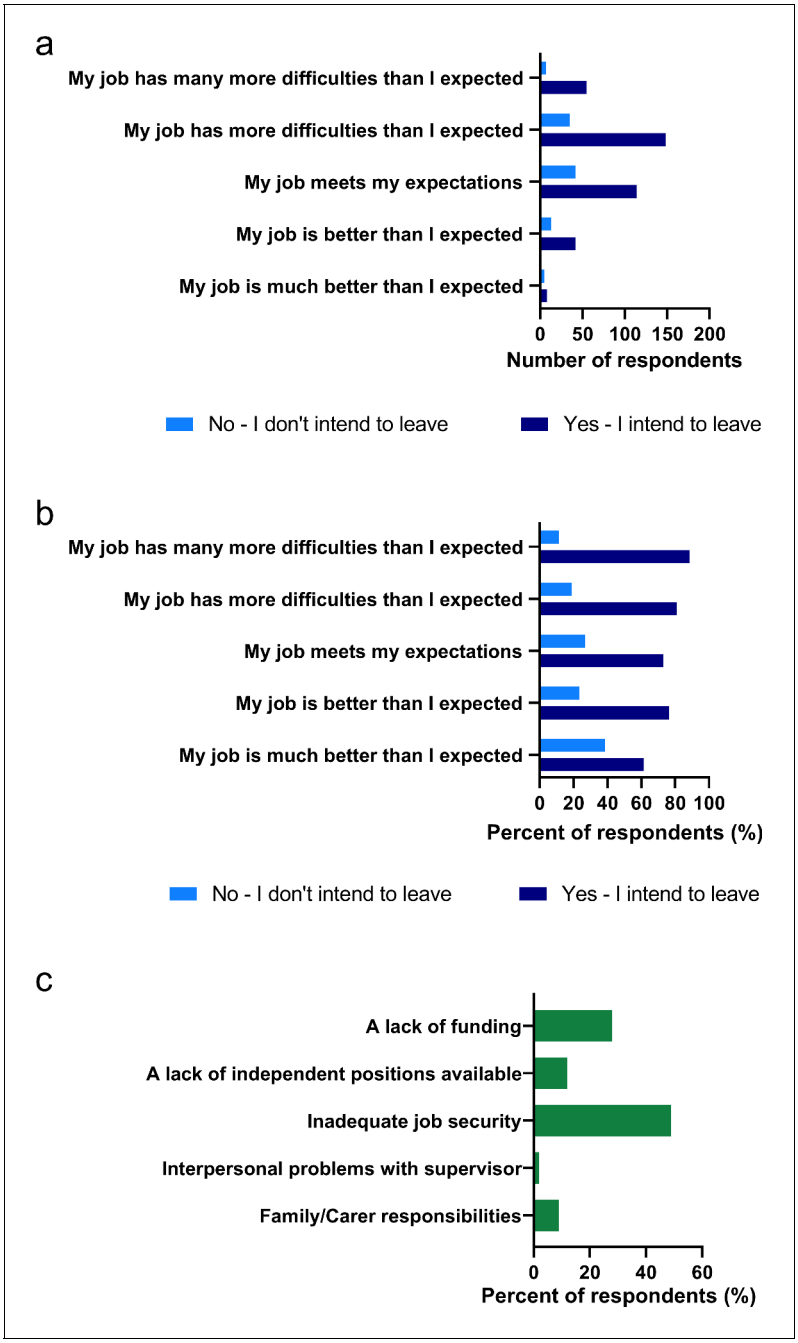


Figure 5. ECRs expectations of their current position and their intention to leave. Answer to survey Question 73, 'How does your job as an early-career researcher meet your original expectations?' (n = 469), and respondents' intention to leave or remain in their position. (a) Data shown as raw number of respondents. (b) Data shown as percentage of each group of respondents. Note correlation between job expectation and intention to leave (n = 469, regression analysis, p=0.0234). (c) These data outline likely reasons for why ECRs would consider leaving a career in research (Question 67 in survey, n = 425, note that 38 answered other and are not accounted for in this graph).

and Medical Research Council (NHMRC) of Australia found that 54% of all survey participants were aware of researchers feeling tempted or under pressure to compromise on research quality, and that junior researchers were most likely to be aware of such instances, while ethics committee members were least likely (NHMRC Australia, 2020). Given the very high stress on individual ECRs and on the system, it is rational to expect that rates of questionable research practice could be on the rise. In 2005, Ioannidis reasoned that 'most published research findings are false', discussing the influence of data selection bias and financial pressures on data interpretation and reported outcomes (Ioannidis, 2005).

Global research pressures have not declined since 2005, and in 2016 Nature published the results from a survey of 1576 researchers on the so-called reproducibility crisis (Baker, 2016). This survey found that pressure to publish and selective reporting were perceived to contribute to greater than 60% of reproducibility problems. Our interpretation of the survey data we collected, where ~ 35% of respondents indicated that questionable research practices had impacted their careers, is that the full extent of known misconduct or data reproducibility problems is likely underestimated. Given that ECRs are both sufficiently trained to identify problems, and often in the laboratory enough to observe these problems, concern from this cohort should be viewed as genuine. Future surveys should ask respondents to characterise what types of questionable research practices they believe are most prevalent, and which are the most harmful.

Our findings highlight the need for institutional and national consideration regarding how pressures are playing out in the Australian STEMM research eco-system. We do not blame institutions or individual ECR mentors for these problems. Few ECRs (1.4%) indicated that they would leave their current position because of poor interpersonal relationships with their supervisor. Rather, we consider that the challenges experienced by ECRs in Australia reflect systemic problems. Most ECRs (78.3%) had considered a major career change in the past five years, including leaving academia all together or moving overseas. If ECRs left their current positions it would be primarily because of lack of funding and job security (total 77.1%). When the ECR responses were delineated based on years post PhD, those who were greater than 4 years post PhD were less satisfied than those who were 4 years or less post PhD. Our observations parallel a previous study that observed that job satisfaction was greater for those who had more recently started their first postdoctoral appointment (Miller and Feldman, 2015).

In our survey, female ECRs indicated experiencing higher rates of inequitable hiring practices and harassment from those in a position of power than their male counterparts. In contrast, more males felt unsafe in their work environment. We also found that both male and female ECRs were concerned about parental/carer responsibilities, knowing that delayed research productivity could compromise their career prospects. Men were more concerned about this than women, possibly reflecting recent efforts to accommodate mothers, but not necessarily families.

Challenges for researchers are not isolated to Australia. A survey by the Wellcome Trust in 2020 of over 4,000 researchers (mostly in the UK) paralleled many of our observations (Wellcome Trust, 2020; Abbott, 2020). While 84% of researchers were proud to work in the research community, only 29% felt secure in pursuing a research career, and 23% of junior researchers and students suggested that they had felt pressured by their supervisor to produce a particular result. In agreement with our findings on 'questionable research practices', 43% of respondents in the Wellcome survey believed that their workplace puts more value on meeting research metrics than the quality of the research. It is clear that these are global challenges that will require intervention at all levels of the research community.

Compounding inefficiencies and suggestions for change

Many current problems in the field could be viewed as inefficiencies. Solving these problems may contribute to improvements at both the personal and community level, thus justifying investment into solutions. For example, a study published in 2015 estimated that $28bn per year is 'spent on preclinical research that is not reproducible – in the United States alone' (Freedman et al., 2015). Although we have not seen similar estimates for Australia, findings from the recent NHMRC survey suggests there are reasons to be concerned (NHMRC Australia, 2020).

A second major source of inefficiency is the low grant funding success rates, coupled with evidence that current mechanisms for ranking applications is unreliable (Graves et al., 2011; Pier et al., 2018; Forscher et al., 2019). In 2012, researchers spent an average 34 days preparing NHMRC grant proposals, only 21% of which were successful; this means that out of the 550 years invested into all applications (3,272 applications), 435 years were spent on unfunded applications (Herbert et al., 2013). These problems are not isolated to the NHMRC; the time-cost of preparing and reviewing grants, coupled with poor ranking reliability, have motivated many to propose transition to outright lotteries (Adam, 2019).

Poor funding rates, and the inherent risk that an individual's salary might not be funded for the next calendar year drive high attrition rates. While the constant flow of eager new PhD graduates into the workforce offers a mechanism to replace those who have exited the system, high turnover should be viewed as another potential source of community level inefficiency. While the less expensive labour of PhD students may help

Table 8. Quotes from ECRs in the survey explaining why they do not leave academia, and their fears regarding employment outside of the academic workplace.

Quote number	Specific response
1	Because it took me so long to earn my PhD, not using it now would seem like a waste. Also, I don't know what else I am qualified to do.
2	I didn't know what the other options were or how to pursue them.
3	I enjoy science. I feel like leaving would be a failure. I try to continue/stay alive until that failure happens.
4	I've spent 10 years training to be an academic. I want to be an academic, but it seems it just isn't my choice at the end of the day. I'll stay until I am no longer competitive. I am keeping my eyes open and looking at other opportunities but so far no one wants me outside academia either.
5	I have no skills in anything else.
6	After 13 years at university, a divorce, my body and mind falling apart, and pulling myself up from grinding childhood poverty and abuse there isn't anything else I feel that I am qualified to do. I am really good at my job yet overqualified and not healthy enough to do anything else. I am stuck here.
7	I also cannot imagine working in another environment, I actually don't know what other options are available and whether these would be fulfilling.
8	I constantly think about leaving academia/research (from necessity not choice) but don't know how and am not qualified for any other jobs.

to balance the budgets of individual laboratories, the process of training many individuals for brief careers in science represents an inefficiency likely to negatively impact national research budgets and output. This workforce inefficiency is almost certainly linked to inefficiencies associated with irreproducible science.

Lastly, our data showed that job security (52%) was the number one reason that Australian STEMM ECRs said they might leave their current position, in agreement with the Wellcome survey which also identified this as a major concern. As a community we need to work to improve job security (take care of our people) and the quality of research data (our product). Below we set out a list of national and international recommendations that could help tackle some of these problems.

Recommendations for Australia

With the goal of stabilising the careers of early-career researchers in science, technology, engineering, mathematics and medicine and maintaining research quality, Australia should consider: (1) An increase in GDP expenditure on research and development to align with other Organization for Economic Co-operation and Development (OECD) nations. (2) Trim PhD completion numbers to better align with current workforce demands. While PhD students offer a sizable and inexpensive workforce, a long-term view of graduate contributions are likely to benefit the field. (3) Research funds should be distributed through smaller and more consistent grants with the goal of supporting the long-term career development of ECRs. Innovation and innovators are rare, and time is required to test ideas and develop gifted researchers. (4) Finally, Australia should establish an independent research ombudsman to oversee research integrity issues. Need for an independent research ombudsman has been discussed previously (Vaux, 2013; Brooks et al., 2016).

Institutional recommendations

At the institutional level, around the world, the research environment for early-career researchers in STEMM disciplines could be improved by: (1) Training mentors to manage the career development of ECRs. (2) Aiming to provide greater career stability through longer contracts. (3) Developing skills training programs that prepare PhD candidates and early-career scientists for employment outside of academia for when long-term academic employment is not viable, and a culture for attending this training. (4) Supporting the development of a research culture that counters questionable research practices by encouraging all academics to ask questions, challenge hype and report honestly.

Limitations of the study

Our survey captured the opinion of 658 early-career researchers working in Australia in STEMM disciplines. It has proven difficult to determine the precise number of such ECRs. There were approximately 23,000 higher education staff in Level A and B positions (all disciplines) in 2019 (Department of Education, Skills and Employment, 2019), but it is not known how many of these were in the STEMM disciplines. Previous work estimated the number of postdoctoral researchers employed in Australia as 6,000 (Hardy et al., 2016). It is likely our survey captured opinion from 5–10% of the target population. As the survey participants were self-selected, it is possible that we attracted a disproportionate number of dissatisfied respondents. Surveys were distributed by third parties at research institutes, or recruited via social media, potentially limiting or biasing distribution and preventing calculation of response rate. This process and its limitations have been reported briefly in Research Ethics Monthly (Christian et al., 2019).

In our survey, we collected some demographic data which could be used to measure diversity. These data included country of birth, language spoken at home, country of PhD, whether respondents lived with a partner (no, heterosexual, same sex or prefer not to say) and chronic disability. However, only 20 (3%) respondents indicated they were in a living with a partner of the same sex, and 3% preferred not to say. Furthermore, we did not collect data on the ethnicity of respondents and therefore cannot know how this may have influenced the findings of our survey. Further research should examine how the challenges identified in this study may vary between diverse groups. We did not observe indications of cultural bias, but this could be because our survey was conducted in English, perhaps selecting for those whose language skill made them well equipped to complete the survey.

Materials and methods

This survey formed one part of a mixed methods research project which explored challenges faced by early-career scientists at universities and at independent research institutes in

Australia. The primary research questions from which the survey questions were derived were; (1) What are the relationships between ECR job satisfaction or dissatisfaction and their likelihood of staying in STEMM? (2) What are the principal factors that shape the ECR experience of various cohorts in the STEMM in Australia? (3) What are the motivations for ECRs leaving their research position? (4) What are the specific features of the experiences and environment of those ECRs who remain in STEMM? The definition of 'early-career researcher' for the purpose of this project included holding a PhD or equivalent, awarded no more than ten years prior and employment in an Australian university or independent research institute in a STEMM discipline.

Survey

Survey questions are included in Supplementary file 1. Quantitative data was collected from 658 respondents in an on-line survey of ECRs working in a scientific environment in universities and research institutes across Australia. Individuals employed in private enterprise/industry, not-for profit entities or in government funded organisations were excluded from this project as their research environments are considered different. The conceptual framework for the study was built on frameworks for job satisfaction for academics developed by Rosser, 2004 and Basak and Govender, 2015 , which identified important factors as workload, job security, job satisfaction, challenges, mentoring and supervision, career planning, intention to leave, career breaks and expectations about the career. Survey questions were selected to explore these factors and were supplemented with questions seeking demographic information which included the institution type, research discipline, country of origin, family situation and work arrangements. In addition, we held focus group discussions which enabled us to identify other important questions, and to optimise our approach. The questionnaire for the survey was developed by first compiling questions, often used in a broader or international context, from research literature including questions from Australian Council of Education Research, The EMCR Forum at the Australian Academy of Science, Federation of Australian Scientific and Technological Societies (FASTS), Global Young Academy, National Science Foundation, Nature Research and Vitae (Christopherson et al., 2014; Hardy et al., 2016; Coates et al., 2008; Coussens et al., 2017; Nature Research and Penny, 2017; Bell and Yates, 2015; Phou, 2015; Vitae, 2018).

In order to cover all the themes identified in the literature as matters relating to job satisfaction or dissatisfaction. Some additional questions were created if no suitable question was identified elsewhere. Questions were combined and modified to create a question bank for this survey relevant to the research questions and the Australian context and further informed by data collected from a focus group of ECRs, after which the survey was pilot tested. In keeping with the conceptual framework for the study, matters investigated include inequity, bias or discrimination with respect to age, gender, inequitable hiring practices and harassment based on different power positions, mentoring and supervision, career planning, training and professional development and work life balance. The data from these questions were supplemented by questions seeking demographic information which included the institution type, research discipline, country of origin, family situation and work arrangements.

The invitation to take part in the survey was distributed via email after direct contact with the institutions, via social media or 'umbrella groups' such as EMCR Forum (Australian Academy of Science, 2020) and The Australian Society for Medical Research (ASMR, 2020) with members or affiliates drawn from the STEMM community who were likely to include the target group.

A focus group discussion attended by seven ECRs on January 30, 2019 evaluated the questionnaire prior to the survey and participants in the focus group offered additional insights. These seven focus group participants were ECRs from five STEMM disciplines and four institutions based in Sydney, Australia who responded to an email invitation that was circulated within Sydney institutions and who were considered to be broadly representative of ECRs in STEMM. All provided informed consent. Once the survey was established, a pilot study (n = 22) permitted testing for understanding and clarity and to check for technical difficulties. The pilot survey ran from February 14 to February 28, 2019. The National survey followed, and the data from the survey is discussed in this paper. The survey ran from March 5 to June 14, 2019. The survey was conducted online using LimeSurvey (v2.01). Eligibility to participate was determined by the initial questions in the survey.

Acknowledgements

Katherine Christian is supported by an Australian Government Research Training Program (RTP) Fee-Offset Scholarship through Federation University Australia. MRD is supported by a NHMRC Fellowship (APP1130013). The Translational Research Institute is supported by Therapeutic Innovation Australia (TIA). The Australian Government supports TIA through the National Collaborative Research Infrastructure Strategy (NCRIS) program. The Authors would like to thank Dr. Kathryn Futrega for critical discussion and figure design.

Katherine Christian is in the School of Arts, Federation University Australia, Ballarat, Australia
katherinechristian@students.federation.edu.au
https://orcid.org/0000-0001-9690-1417
Carolyn Johnstone is in the School of Arts, Federation University Australia, Ballarat, Australia
Jo-ann Larkins is in the School of Engineering, Information Technology and Physical Sciences, Federation University Australia, Churchill, Australia
Wendy Wright is in the School of Science, Psychology and Sport, Federation University Australia, Churchill, Australia
https://orcid.org/0000-0003-3388-1273
Michael R Doran is in the School of Biomedical Sciences and Centre for Biomedical Technologies within the Queensland University of Technology at the Translational Research Institute, Brisbane, Australia. He is also affiliated with the Mater Research Institute in Brisbane, Australia and the National Institute of Dental and Craniofacial Research at the National Institutes of Health in Bethesda, United States
michael.doran@qut.edu.au
https://orcid.org/0000-0001-5876-4757

Author contributions: Katherine Christian, Conceptualization, Data curation, Formal analysis, Validation, Investigation, Methodology, Writing - original draft, Project administration, Writing - review and editing; Carolyn Johnstone, Jo-ann Larkins, Wendy Wright, Conceptualization, Resources, Formal analysis, Supervision, Validation, Methodology, Writing - original draft, Writing - review and editing; Michael R Doran, Conceptualization, Formal analysis, Validation, Methodology, Writing - original draft, Writing - review and editing

Competing interests: The authors declare that no competing interests exist.

Received 06 July 2020
Accepted 21 December 2020
Published 11 January 2021

Ethics: Human subjects: This study has been conducted according to the guidelines of the ethical review process of Federation University Australia and the National Statement on Ethical Conduct in Human Research (Approval Number 18/139A). Voluntary and informed participants contributed to these data. All provided informed consent.

Funding

Funder	Grant reference number	Author
National Health and Medical Research Council	APP1130013	Michael R Doran

The funders had no role in study design, data collection and interpretation, or the decision to submit the work for publication.

Decision letter and Author response
Decision letter https://doi.org/10.7554/eLife.60613.sa1
Author response https://doi.org/10.7554/eLife.60613.sa2

Additional files

Supplementary files

- Supplementary file 1. Questions from online survey.
- Supplementary file 2. Comparison of satisfaction data from this survey and historical surveys in Australia.
- Transparent reporting form

Data availability

The data set for this paper has been uploaded to Federation University Figshare, which is an open access data base. DOI 10.25955/5f98c272a6ef5. These data has been purged of institution name, country of birth and identifying statements made in open text responses. Most of the remaining survey data is likewise be available. Some project data is subject to embargo to protect the anonymity of participants however it may be shared subject to the approval of the Federation University of Australia Human Research Ethics Committee. See https://federation.figshare.com/projects/Challenges_Faced_by_Early-Career_Researchers_in_the_Sciences_in_Australia_and_the_Consequent_Effect_of_those_Challenges_on_their_Careers_a_Mixed_Methods_Project/90317 .

The following dataset was generated:

Author(s)	Year	Dataset URL	Database and Identifier
Christian K	2020	https://doi.org/10.25955/5f98c272a6ef5	Figshare, 10.25955/5f98c272a6ef5

References

Abbott A. 2020. Stress, anxiety, harassment: huge survey reveals pressures of scientists' working lives. Nature 577:460–461. DOI: https://doi.org/10.1038/d41586-020-00101-9, PMID: 31965094

Adam D. 2019. Science funders gamble on grant lotteries. Nature 575:574–575. DOI: https://doi.org/10.1038/d41586-019-03572-7
ASMR. 2020. The Australian Society for Medical Research (ASMR). https://asmr.org.au [Accessed December 12, 2020].
Australian Academy of Science. 2020. About the EMCR forum. https://www.science.org.au/supporting-science/early-and-mid-career-researchers-0/about-emcr-forum [Accessed December 21, 2020].
Australian Research Council. 2019. The state of Australian university research 2018–19, ERA National Report. https://www.arc.gov.au/excellence-research-australia/era-reports [Accessed December 21, 2020].
Baker M. 2016. 1,500 scientists lift the lid on reproducibility. Nature 533:452–454. DOI: https://doi.org/10.1038/533452a, PMID: 27225100
Basak SK, Govender DW. 2015. Theoretical framework of the factors affecting university academics job satisfaction. International Business & Economics Research Journal 14:317–326. DOI: https://doi.org/10.19030/iber.v14i2.9167
Begley CG, Ellis LM. 2012. Raise standards for preclinical cancer research. Nature 483:531–533. DOI: https://doi.org/10.1038/483531a
Bell S, Yates L. 2015. Women in the science research workforce: identifying and sustaining the diversity advantage. https://core.ac.uk/download/pdf/47206077.pdf [Accessed December 21, 2020].
Bexley E, James R, Arkoudis S. 2011. The australian academic profession in transition: addressing the challenge of reconceptualising academic work and regenerating the academic workforce. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0010/1490923/The_Academic_Profession_in_Transition_Sept2011.pdf [Accessed December 21, 2020].
Brooks PM, Vaux DL, Williamson R. 2016. Australia needs an ombudsman or office for research integrity. Internal Medicine Journal 46:1233–1235. DOI: https://doi.org/10.1111/imj.13211, PMID: 27734623
Christian K, Johnstone C, Larkins J-a, Wright W. 2019. The need to seek institutional approval to survey staff – was this a misunderstanding of the purpose of Guideline 2.2.13 in the National Statement on Ethical Conduct in Human Research? https://ahrecs.com/the-need-to-seek-institutional-approval-to-survey-staff-was-this-a-misunderstanding-of-the-purpose-of-guideline-2-2-13-in-the-national-statement-on-ethical-conduct-in-human-research/ [Accessed December 21, 2020].
Christopherson S, Martin R, Sunley P, Tyler P. 2014. Reindustrialising regions: Rebuilding the manufacturing economy? Cambridge Journal of Regions, Economy and Society 7:351–358. DOI: https://doi.org/10.1093/cjres/rsu023
Coates H, Goedegebuure L, van der Lee J, Meek L. 2008. The Australian academic profession in 2007 survey methodology and response analysis. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0006/2565069/The-Australian-Academic-Profession-in-2007-Survey-Methodology-and-Response-Analysis.pdf [Accessed December 21, 2020].
Coates H, Dobson I, Edwards D, Friedman T, Goedegebuure L, Meek L. 2009. The attractiveness of the Australian academic profession: a comparative analysis. https://research.acer.edu.au/higher_education/11 [Accessed December 21, 2020].
Coussens A, Erastus FK, Badre A, Akindele A. 2017. Global state of young scientists (GLoSYS) Africa survey. https://globalyoungacademy.net/activities/the-global-state-of-young-scientists/ [Accessed May 29, 2017].
Department of Education, Skills and Employment. 2019. Australian government. 2019 staff fulltime equivalence. https://docs.education.gov.au/node/53181 [Accessed December 21, 2020].
Edwards MA, Roy S. 2017. Academic research in the 21st century: maintaining scientific integrity in a climate of perverse incentives and hypercompetition. Environmental Engineering Science 34:51–61. DOI: https://doi.org/10.1089/ees.2016.0223, PMID: 28115824
Else H. 2019. Nearly half of US female scientists leave full-time science after first child. Nature. DOI: https://doi.org/10.1038/d41586-019-00611-1
Evaristo J. 2020. Avoiding immigration limbo. Science 367:594. DOI: https://doi.org/10.1126/science.367.6477.594, PMID: 32001658
Faulkner W. 2009. Doing gender in engineering workplace cultures. I. Observations from the field. Engineering Studies 1:3–18. DOI: https://doi.org/10.1080/19378620902721322
Forscher PS, Brauer M, Cox WTL, Devine PG. 2019. How many reviewers are required to obtain reliable evaluations of NIH R01 grant proposals? PsyArXiv. DOI: https://doi.org/10.31234/osf.io/483zj
Freedman LP, Cockburn IM, Simcoe TS. 2015. The economics of reproducibility in preclinical research. PLOS Biology 13:e1002165. DOI: https://doi.org/10.1371/journal.pbio.1002165, PMID: 26057340
Gewin V. 2018. What does it take to make an institution more diverse? Nature 558:149–151. DOI: https://doi.org/10.1038/d41586-018-05317-4, PMID: 29875492
Ghaffarzadegan N, Hawley J, Larson R, Xue Y. 2015. A note on PhD population growth in biomedical sciences. Systems Research and Behavioral Science 32:402–405. DOI: https://doi.org/10.1002/sres.2324
Graves N, Barnett AG, Clarke P. 2011. Funding grant proposals for scientific research: retrospective analysis of scores by members of grant review panel. BMJ 343:d4797. DOI: https://doi.org/10.1136/bmj.d4797, PMID: 21951756
Hardy MC, Carter A, Bowden N. 2016. What do postdocs need to succeed? A survey of current standing and future directions for Australian researchers. Palgrave Communications 2:16093. DOI: https://doi.org/10.1057/palcomms.2016.93
Herbert DL, Barnett AG, Clarke P, Graves N. 2013. On the time spent preparing grant proposals: an observational study of Australian researchers. BMJ Open 3:e002800. DOI: https://doi.org/10.1136/bmjopen-2013-002800, PMID: 23793700
Innovation, Australian Government. 2017. Science Australia. Australia 2030: prosperity through innovation. https://www.industry.gov.au/sites/default/files/May%202018/document/extra/australia-2030-prosperity-through-innovation-summary.pdf?acsf_files_redirect [Accessed December 21, 2020].
Ioannidis JP. 2005. Why most published research findings are false. PLOS Medicine 2:e124. DOI: https://doi.org/10.1371/journal.pmed.0020124, PMID: 16060722

Jackson D, Michelson G. 2015. Factors influencing the employment of Australian PhD graduates. Studies in Higher Education 40:1660–1678. DOI: https://doi.org/10.1080/03075079.2014.899344
John LK, Loewenstein G, Prelec D. 2012. Measuring the prevalence of questionable research practices with incentives for truth telling. Psychological Science 23: 524–532. DOI: https://doi.org/10.1177/0956797611430953, PMID: 22508865
Johnsrud LK, Rosser VJ. 2002. Faculty members' morale and their intention to leave. The Journal of Higher Education 73:518–542. DOI: https://doi.org/10.1353/jhe.2002.0039
Lee A, Dennis C, Campbell P. 2007. Nature's guide for mentors. Nature 447:791–797. DOI: https://doi.org/10.1038/447791a, PMID: 17568738
Li W, Aste T, Caccioli F, Livan G. 2019. Early coauthorship with top scientists predicts success in academic careers. Nature Communications 10:5170. DOI: https://doi.org/10.1038/s41467-019-13130-4
McCarthy PX, Wienk M. 2019. Advanceing Australia's knowledge economy: who are the top PhD employers? https://amsi.org.au/wp-content/uploads/2019/04/advancing_australias_knowledge_economy.pdf [Accessed December 21, 2020].
Miller JM, Feldman MP. 2015. Isolated in the lab: examining dissatisfaction with postdoctoral appointments. The Journal of Higher Education 86: 697–724. DOI: https://doi.org/10.1353/jhe.2015.0029
Nature Research, Penny D. 2017. Anonymised raw data and questionnaire from Springer Nature's 2017 Graduate Survey. Figshare. DOI: https://doi.org/10.6084/m9.figshare.5480716.v3
NHMRC Australia. 2020. Survey of research culture in Australian NHMRC-funded institutions: key messages. https://www.nhmrc.gov.au/research-policy/research-quality [Accessed December 21, 2020].
NTEU State of the Uni Survey. 2017. Australia: National Tertiary Education Union's State (NTEU) of the Uni Survey 2017. https://issuu.com/nteu/docs/sotus_2017_report_1_overview [Accessed December 21, 2020].
Pain E. 2014. An emerging global picture of early-career scientists. Science. https://www.sciencemag.org/careers/2014/01/emerging-global-picture-early-career-scientists [Accessed December 21, 2020].
Phou K. 2015. Questionnaire for National Science Foundation survey 2015. https://www.nsf.gov/statistics/srvyecd/#sd&qs&tabs-1January 5, 2021].
Pier EL, Brauer M, Filut A, Kaatz A, Raclaw J, Nathan MJ, Ford CE, Carnes M. 2018. Low agreement among reviewers evaluating the same NIH grant applications. PNAS 115:2952–2957. DOI: https://doi.org/10.1073/pnas.1714379115, PMID: 29507248
Potvin DA, Burdfield-Steel E, Potvin JM, Heap SM. 2018. Diversity begets diversity: A global perspective on gender equality in scientific society leadership. PLOS ONE 13:e0197280. DOI: https://doi.org/10.1371/journal.pone.0197280, PMID: 29847591
Professionals Australia. 2014. All talk: Gap between policy and practice a key obstacle to gender equity in STEM: 2018 women in STEM professions survey report. https://www.voced.edu.au/content/ngv:81099 [Accessed December 21, 2020].
Rosser VJ. 2004. Faculty members' intentions to leave: a national study on their worklife and satisfaction. Research in Higher Education 45:285–309. DOI: https://doi.org/10.1023/B:RIHE.0000019591.74425.f1
Sá CM, Sabzalieva E. 2018. The politics of the great brain race: public policy and international student recruitment in Australia, Canada, England and the USA. Higher Education 75:231–253. DOI: https://doi.org/10.1007/s10734-017-0133-1
Smith DK. 2020. The race to the bottom and the route to the top. Nature Chemistry 12:101–103. DOI: https://doi.org/10.1038/s41557-019-0410-y, PMID: 31996806
van den Brink M, Benschop Y. 2014. Gender in academic networking: the role of gatekeepers in professorial recruitment. Journal of Management Studies 51:460–492. DOI: https://doi.org/10.1111/joms.12060
Vaux DL. 2013. From fraud to fair play: Australia must support research integrity. https://theconversation.com/from-fraud-to-fair-play-australia-must-support-research-integrity-15733 [Accessed December 21, 2020].
Vitae. 2018. Background for careers in research online survey, (Realising the potential of Researchers). https://www.vitae.ac.uk/impact-and-evaluation/cros [Accessed December 21, 2020].
Wellcome Trust. 2020. What researchers think about the culture they work in. https://wellcome.ac.uk/sites/default/files/what-researchers-think-about-the-culture-they-work-in.pdf [Accessed December 21, 2020].
Weller S, O'Neill P. 2014. De-industrialisation, financialisation and Australia's macro-economic trap. Cambridge Journal of Regions, Economy and Society 7:509–526. DOI: https://doi.org/10.1093/cjres/rsu020
Woolston C. 2014. How not to deal with the PhD glut. Nature . DOI: https://doi.org/10.1038/nature.2014.16182
Woolston C. 2017. Graduate survey: a love–hurt relationship. Nature 550:549–552. DOI: https://doi.org/10.1038/nj7677-549a
Woolston C. 2019. PhDs: the tortuous truth. Nature 575:403–406. DOI: https://doi.org/10.1038/d41586-019-03459-7, PMID: 31723297
Zimmerman CA, Carter-Sowell AR, Xu X. 2016. Examining workplace ostracism experiences in Academia: understanding how differences in the faculty ranks influence inclusive climates on campus. Frontiers in Psychology 7:753. DOI: https://doi.org/10.3389/fpsyg.2016.00753, PMID: 27303322

As previously explained, the manuscript (Christian et al., 2021) above, widely explores answers to the on-line survey questions, producing a picture of the workplace experience for ECRs in Australia. Regrettably, it provides evidence of a culture often negligent of the needs of ECRs, including reports of impact on themselves or their career from poor supervision (60%), inequitable hiring practices (39%) and bullying or harassment (34%).

A concerning rate of "questionable research practices" by colleagues from both within and outside their institutions (31.9% from colleagues outside to 38.1% from colleagues inside) was reported to have impacted ECR career advancement. The findings about questionable research practices are explored further in an article published in a peer-reviewed blog, Research Ethics Monthly (Christian et al., 2020a) included below (with the permission of the publishers).

4.2.3 Article: What are Questionable Research Practices as Reported by ECRs in STEMM in Australia? (Christian et al., 2020a)

4.2.3.1 Position of Christian et al. (2020a) in the Thesis

This article was prepared as part of my PhD research. It was published in Research Ethics Monthly, a peer-reviewed blog managed by Australasian Human Research Ethics Consultancy Services (AHRECS) which features articles on human research ethics and research integrity matters of relevance to researchers. This article is included in the thesis as it contributes to understanding of the research environment as experienced by the ECRs, providing background for the answers to all the research sub-questions; one: "What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?", two: "What are the motivations for leaving the sciences? and three: "What are the

specific features of the experiences and environment of those ECRs who remain in the sciences?". This article reports many specific instances of questionable research practices in the workplace, clearly painting a picture of the undesirable experiences of some of those 34% 41% of respondents who reported poor behaviours from their supervisors and colleagues and providing sound reasons for leaving the sciences. The article is included below in the format in which it was published.

What are Questionable Research Practices as Reported by ECRs in STEMM in Australia?

Early-career researchers (ECRs) across the world have long reported significant difficulties caused by lack of funding and consequent job insecurity, gender inequity, work/life imbalance, and poor or insufficient professional development. The overall picture from our research project about ECRs in STEMM fields in Australia is of people who love science employed in unsatisfactory workplaces and overwhelmed by job insecurity and its consequences. We investigated the workplace experiences of ECRs working in the sciences in universities and independent research institutes across Australia, collecting data in a national survey (n=658), and through eight interviews of women who had recently left the academic workplace for alternate careers.

As we previously described (Christian et al., 2020), a concerning 38% ECRs reported questionable research practices from colleagues inside their institution and 32% from colleagues outside their institution. While "questionable research practices" were not defined within the survey, and there was no opportunity provided for respondents to expand in the context of this question, this term has been used to describe behaviours ranging from fraud to data exclusion and rounding of p-values (John et al., 2012). Qualitative data collected from other questions provided insights into practices which give cause for concern. These quotes,

which speak for themselves, provide some indication of what our respondents identified as questionable research practices:

> I have also encountered some antisocial behaviour among academics, such as senior staff who have attempted to "steal" work I am doing to present as their own. It's cutthroat. (ECR A)
>
> My supervisor is unethical and a scoundrel who makes this job terrible. She exists to feather her own nest and ECRs are a commodity to use to this end. (ECR B)
>
> I've found that highly respected research groups often have less integrity than you'd initially thing (sic). QRPs [questionable research practices] are worryingly common, and engaged in to chase funding to conduct more QRP studies (ECR C)
>
> Lack of funding and the need to 'sell' your research often leads to many researchers fabricating and embellishing data. This leads to the inability of genuine researchers to replicate findings, wasting precious time and resources, giving up and then their contracts not being renewed because the boss doesn't get the 10 publications per year they demand. (ECR D)
>
> I believe that the whole Academia environment is corrupted and has lost its true vision. The lack of funding is making researchers to sometimes make-up data to get grants or to publish meaningless papers just for the sake of raising the numbers. (ECR E)
>
> In our national survey, 60% percent of STEMM ECRs reported they had been impacted by lack of support from supervisors, 33% by bullying and harassment based on power position and 13% said they felt unsafe in the workplace (unexpectedly 16% men felt unsafe compared with 11% women)

(Christian et al.,2020). These comments encapsulate many of the issues which point to the poor workplace practices identified by our respondents:

> The institutional work culture is a major concern (bullying, academic misconduct, workplace safety etc., which goes un-noticed) (ECR F)

> I am currently looking outside academia to get away from the culture of harassment… it takes too much of a toll on my health… but I would stay in academia if I were to find a position that didn't subject me to harassment by a supervisor. (ECR G)

> Being yelled at by my supervisor on a regular basis, being yelled at by his students due to my supervisor lying to the students, being unable to lodge complaints as it's made clear that I will not have my contract continued and will have difficulty finding another job without references if I lodge a complaint. (ECR H)

The themes which emerged from these data include ECRs feeling the need or wish to leave their jobs because of workplace stress related to job insecurity, poor institutional culture or harassment from supervisors. In parallel, we learnt why ECRs stay and tolerate these conditions: they love their research, their actual work. This puts them in a quandary about whether to stay or go and there is clear uncertainty about what to do next, either because there is nowhere to go or because the options are unpalatable.

If our government is to achieve its stated aim of making Australia one of the best places in the world in which to undertake innovation, science and research, and to maximise the spread of benefits to all Australians (Department of Industry Innovation and Science, 2018), then we must take better care of ECRs in STEMM fields who will form this future workforce. We must address a research culture where questionable research practices,

whatever form they take, are so prevalent and, instead, work harder to change the culture and foster the high standards of research integrity called for in our Australian Code of Responsible Research Practice. These practices do not have to be tolerated; instead our research institutions must provide all staff, particularly ECRs, with safe avenues to report inappropriate behaviours – and follow up, every time, with appropriate action.

Limitations

As participants in the survey self-selected, it is possible we may have attracted more dissatisfied people to the study than is representative, or only people who had the time available to respond. Also, as this survey is long and conducted only in English, people from culturally and linguistically diverse backgrounds may be under-represented.

It is not possible to know the response rate to invitations received by potential participants. As a consequence of the approval process required by the HREC, distribution of those invitations was usually not within our direct control and instead was either managed by a third party or was recruitment via directed social media. This process was reported briefly in Research Ethics Monthly (Christian et al., 2019).

The findings described in both Christian et al. (2020a) and Christian et al. (2021) provide similar data to those shown in a recent report, equally concerning, which characterised the health of the research industry in the UK (Wellcome Trust, 2020). It seems that the research community needs to improve job security (care for our people) as well as the quality of research data (our product) internationally, nationally and institutionally as both appear to be at risk.

Views of ECRs about questionable research practices merit further research, as the wording of the on-line survey questions did not provide an opportunity for further exploration of either the meaning to individuals of "questionable research practices" or their consequences to the individuals concerned. The most common types of research misconduct observed (though not necessarily reported) in the research environment in The Netherlands were plagiarism, authorship issues, cherry picking, falsification, text recycling and data manipulation (Horbach et al., 2020). The younger researchers, researchers with temporary appointments and those in lower academic positions, i.e. people in similar positions to many of our respondents, were fearful of reporting misconduct. These Dutch ECRs felt reporting misconduct may harm their career or else they expected not to be taken seriously; both situations are consequent to imbalance of power which is reported as leading to bullying and harassment concerns in my study, so it is a matter of concern that Australian ECRs might, too, be fearful of reporting misconduct.

4.3 Exploring Known Factors Contributing to Job Satisfaction for ECRs in STEMM

The factors I have identified in the literature (previously discussed in Chapter 2) as likely to contribute to job satisfaction include job security, feeling valued, freedom to pursue research interests, provision of good leadership, supervision and mentoring (including a beneficial review process), a good workplace culture, a culture of inclusion and diversity, support for career and confidence in career prospects, feeling safe, work-life balance and flexibility and salary and remuneration.

As a first step in my examination of job satisfaction for participants in this study I sought to examine major factors contributing to job satisfaction by cohort. Of necessity this involves some examination of specific factors within the cohort, however later in this chapter

(Section 4.3.2) I will address individual factors contributing to job satisfaction for the whole cohort.

4.3.1 Job Satisfaction by Cohort

In this section I examine job satisfaction for various sectors of the ECR workforce, and I answer the first research sub-question "What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?", investigating whether these experiences are similar throughout the academic STEMM environments or whether there are differences within various cohorts. I first explore job satisfaction by gender, then for people with and without children, by people grouped by number of years postdoctoral, age, work type and country of birth. As mentioned above, some individual factors which shape the experience of all ECRs in STEMM are further examined in Section 4.3.2 of this Chapter.

In addition to the work reported in Christian et al. (2021), which contributes to Section 4.2 of this chapter, I have explored the views of several cohorts within the respondent population in order to characterise any differences. Demographic questions in the on-line survey permitted the investigation of job satisfaction with regard to gender, number of years postdoctoral, discipline, nature of employment and various personal criteria including country of birth and family situation. I analysed responses to on-line survey questions for the whole cohort and then investigated those responses by sub-group. The levels of job satisfaction may be compared with the job satisfaction of the Australian workforce as a whole, calculated as 82% satisfied for all workers and 80% for those with postgraduate degrees (Cassells, 2017).

4.3.1.1 Gender Equity'

In spite of concerted efforts to address it, gender inequity is still causing concern for people in the sciences in Australia and elsewhere. In a special edition of Nature in 2013 the

editor led with the view that “science remains institutionally sexist, reporting that despite some progress, women scientists were still paid less, promoted less, won fewer grants and were more likely to leave research than similarly qualified men. The reasons ranged from overt and covert discrimination to the unavoidable coincidence of the productive and reproductive years.” ([Editor, Nature], 2013, p.21). While this article was published in 2013, there are many more recent instances such as this to be found in the literature and the situation appears to be largely unchanged (Johnston, 2020; Smith, 2020).

Moss-Racusin et al. (2012) researched the gender bias of faculty members in the USA. This study shows in a randomised, double blind study that faculty members were more likely to favour males rather than females when selecting employees for a laboratory job, despite identical applications. The assigned starting salaries were also higher for male applicants compared to female applicants. Surprisingly, results showed that female faculty members were equally likely to discriminate against female applicants. This clearly demonstrates an overarching ingrained bias against women in the research workforce in the United States. Later work further explored the consequences of STEM gender biases, and concluded they are two-fold, in that they can both interrupt the progress of individual women in STEM who encounter them, as well as deterring women from entering STEM fields in favour of environments which are more equitable (Moss-Racusin et al., 2018).

There are varied opinions amongst those who are committed to the study of gender equity on some issues. Two notable issues are:

1. The differences in “work style” between men and women (where women are perceived as less aggressive than men) (Sattari & Sandefur, 2019) and whether these style differences matter.

2. Whether it is possible and/or desirable for a carer of young children (usually the mother) to move from full-time to part-time work, and whether working part time is a sustainable approach in an inherently competitive workforce.

A significant cause for noticeable gender gaps is rooted in gender-specific dropout rates and subsequent differences in the length of the publishing career and overall productivity for women (Huang et al., 2020). Active female and male scientists have largely indistinguishable yearly performance and receive a comparable number of citations for the same size body of work, however each year, throughout their careers, women scientists have a 19.5% higher risk to leave academia than male scientists, giving male authors a major cumulative advantage over time. Huang et al. suggest in the light of this data that we must readdress the sustainability of woman's careers in academia, at every stage. Overall, the literature suggests that current approaches to tackling gender equity in STEM have been fragmented and to date have not been sufficiently successful.

4.3.1.1.1 Gender Equityin Australia

Bell (2009) assessed the gender equity problems in the Australian STEM workforce articulating many of the hurdles faced by female early- and mid-career researchers; her findings were similar to those described above. She identified two separate, but often compounding, issues which align with those described above, and which remain relevant now, over a decade later:

- Fewer women hold senior leadership roles than men
- Women leave technical and scientific positions at a greater rate than men (either for other sectors, or to leave the workplace entirely)

Bell (2009) found two striking themes emerged from her study of women in research:

- The difference in styles of working, where women tend to be more collaborative and less self-promoting, and
- The challenges of balancing a career in science with motherhood/primary carer role.

Women are still under-represented in higher echelons at the universities in Australia, are awarded a lower number of grants (as opposed to having a lower success rate – there are fewer applications) and have a lower publication rate. It seems the paucity of women at senior levels in research in Australia will not change unless we actively implement change (Mackay, 2020). It has been recommended that institutions must support the development and continuation of programs and initiatives designed to achieve better gender equity, prioritising those sectors with the greatest imbalance (Science and Technology Australia, 2019). The situation for medicine is similar to that for STEM disciplines as Australian Institute of Health and Welfare figures show that women make up 53% of early-career practitioners, including just over half of all specialists-in-training, but only 40% of the medical workforce. Women are not progressing through to senior positions in representative numbers. Only 11% of surgeons are women (Bartone et al., 2019).

Women comprised 29% of the academic research workforce in STEM fields in 2017. While some STEM fields had greater representation of women at junior levels, representation of women at senior levels was extremely low and women comprised only 12% of the highest academic seniority level (Department of Industry, Science, Energy and Resources., 2020). It is not clear if gender bias such as is described by Moss-Rascusin et al. (2018) exists in Australia, but it seems likely to be the case as it has been shown to be prevalent in the general workforce (Wood et al., 2020). The loss of so many women scientists is a significant waste of

expertise, talent and investment, and this impacts our nation's scientific performance and productivity.

The Australian Science Academy (ASA), in collaboration with the Australian Academy of Technology and Engineering, concerned we are losing women from the Australian science sector, has developed The Women in STEM Decadal Plan (Shine et al., 2019) to guide building of the strongest STEM workforce possible to support Australia's prosperity. ASA suggests Australia needs to urgently address the barriers of gender equity to:

- retain our best scientists and innovators to ensure Australia effectively maintains research and development excellence
- keep our best and brightest minds in the fields in which they have the most potential to deliver
- ensure social and economic returns on the hundreds of millions of taxpayer dollars spent each year on training women scientists, by supporting them.

Many universities and institutes have already started tackling gender equity issues, aiming to redress gender stereotypes, and encourage women to reach their full potential as scientific researchers (Dunstone & Williamson, 2016). The benefits of these initiatives are now emerging and Dunstone and Williams present two examples of good institutional practice, The Walter and Eliza Hall Institute for Medical Research (WEHI) and Monash University. Their initiatives include establishment of Gender Equity Committees, support for women to give major lectures, mentorship schemes, female representation on all committees, family-friendly meeting times and peer support offered by women for women.

4.3.1.1.2 Findings for Job Satisfaction by Gender

Contrary to what one might expect given the situations outlined above and elsewhere in the literature, which expound the difficulties faced by women in STEMM findings from my study, described in detail below, showed there was very little difference between the views of male and female respondents in overall satisfaction. The efforts to address gender equity issues in STEMM in Australia may be contributing to the satisfaction of ECR women, however as there is no previous measure of job satisfaction for the same cohort in Australia this cannot be stated with any certainty. Responses to the same question, reported by Bell and Yates (2015) (data collected in 2012-13). show that 68% women (women of all levels in biological sciences in STEM, not just ECRs) agree or strongly agree that "overall they find their work rewarding", men in the same field reported 64%. As the samples contain people at all levels, comparisons cannot be reliable. I note that in the general population (i.e. outside STEMM) job satisfaction for males and females has also been found to be almost the same (men 82%, women 83%) (Cassells, 2017).

4.3.1.1.3 Factors where Levels of Job Satisfaction were Similar for Men and Women

Figures 8 to 15, below, show answers to some on-line survey questions where it was expected from reports in the literature there might be a difference in satisfaction - but in fact there was not.

Figure 8:

Respondents' Satisfaction with their Workplace's Commitment to a Diverse and Inclusive Workplace, by Gender

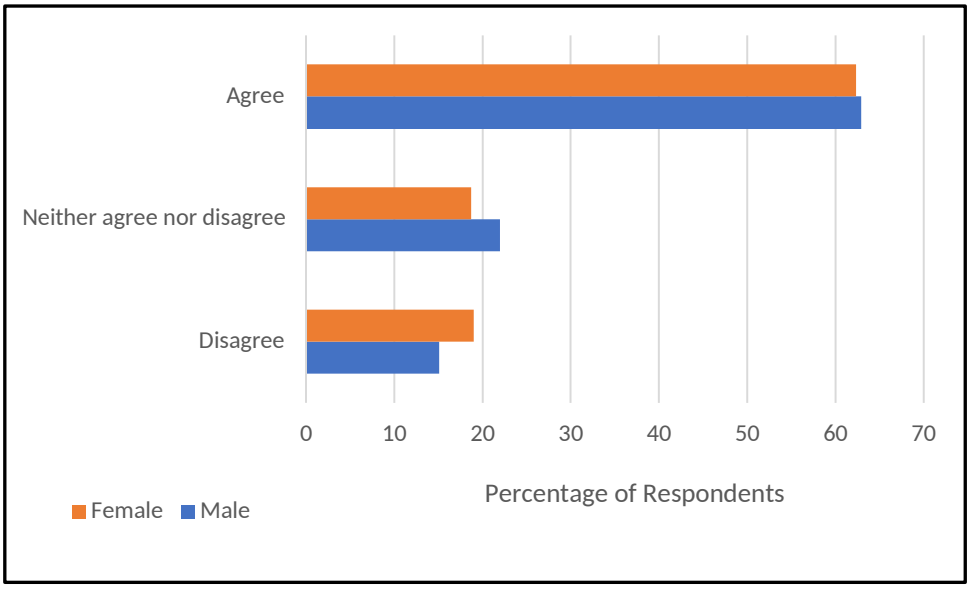


Figure 8 shows women and men have an almost equal level of agreement (women 62.3%, men 62.9%) (Chi-square = 0.716, df = 2, p = 0.699) on their satisfaction with their workplace's commitment to a diverse and inclusive environment. Only 15.1% men and 19.0% women disagree with this statement. The p value indicates no significant difference so supports this interpretation of the data.

Figure 9:

Respondents' Overall Job Satisfaction with their Current Job, by Gender

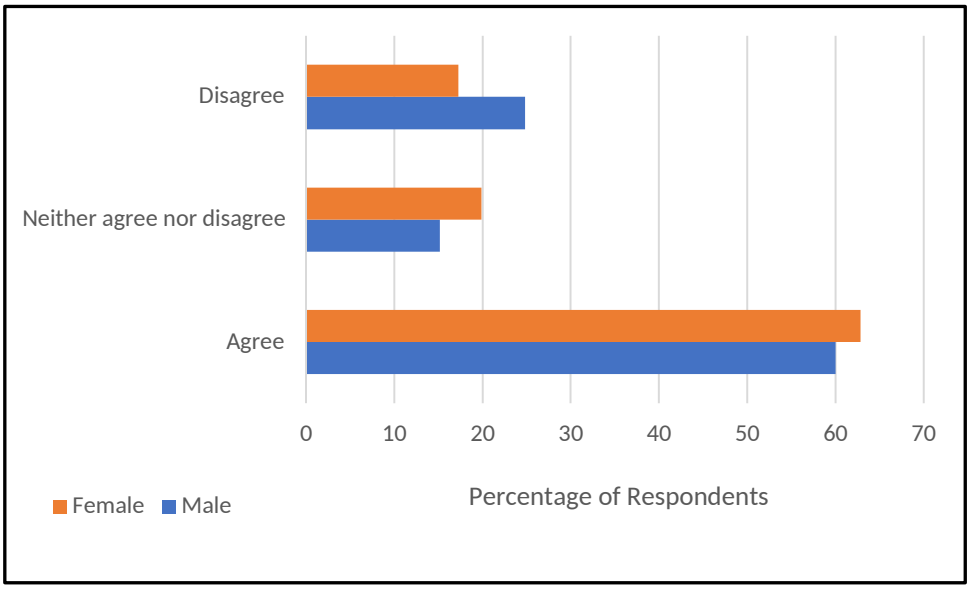


Figure 9 shows overall job satisfaction is very similar for women (62.8%) and men (60.0%) (Chi-square = 2.029, df=2, p= 0.3663). Again, the p value indicates no significant difference so supports this interpretation of the data.

Figure 10:

Respondents' Views of the Nature of the Job as an Early-Career Scientist Compared with their Original Expectations, by Gender

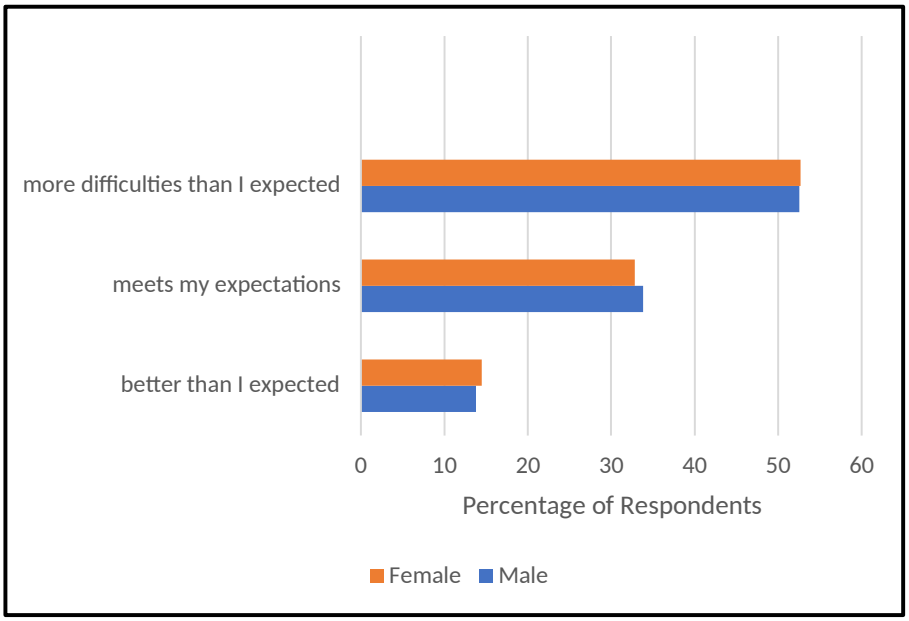


Figure 10 shows women and men find their jobs are more difficult than they had originally expected, again in almost equal measure (women 52.7%, men 52.5%) (Chi-square = 0.33, df =2, p = 0.984). As above, the p value indicates no significant difference.

Figure 11:

Respondents' Confidence that their Work/Contributions are Valued by their Employer, by Gender

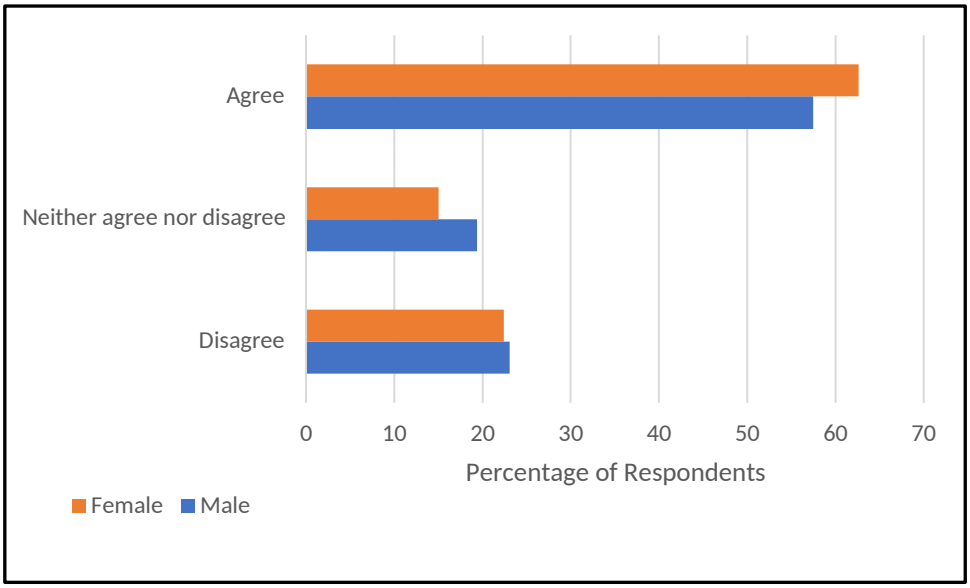
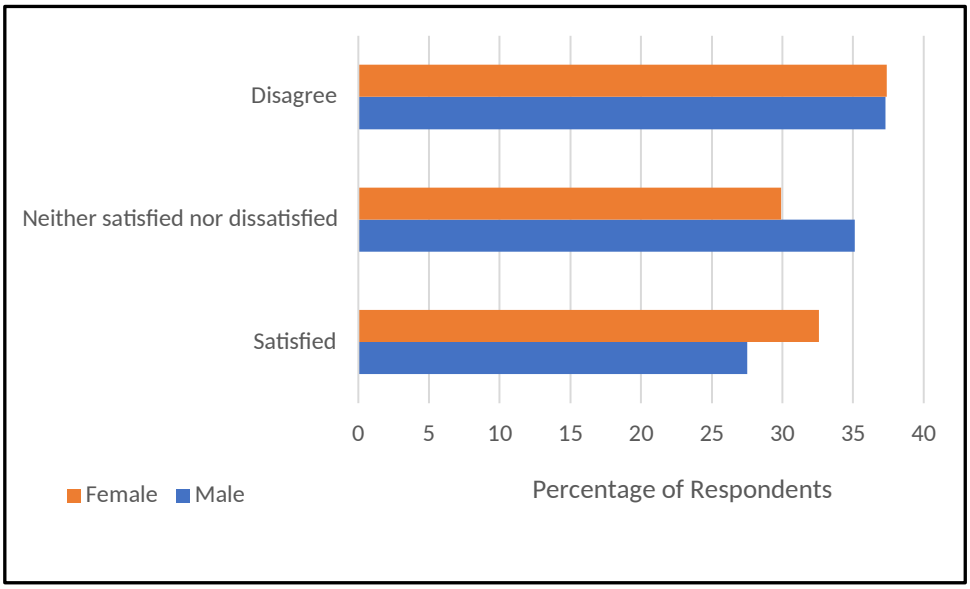


Figure 11 suggests women are marginally more confident (62.6%) their work is valued than are men (57.5%), though the difference is not significant (Chi-square = 0.79, df=2, p= 0.674).

Figure 12:

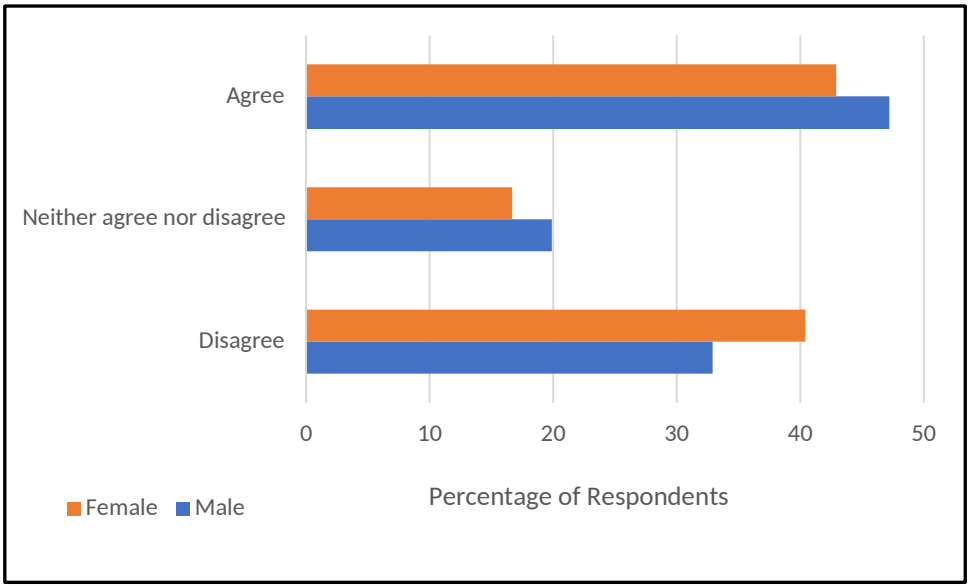
Level of Satisfaction with the Criteria for Promotion, by Gender



While the level of satisfaction for criteria for promotion, shown in Figure 12, is not high for either gender, (men 37.3%, women 37.4%) (Chi-square = 0.849, df=2, p= 0.654) the levels of satisfaction are similar. The p value indicates there is no significant difference between men and women regarding the level of satisfaction regarding promotion.

Figure 13:

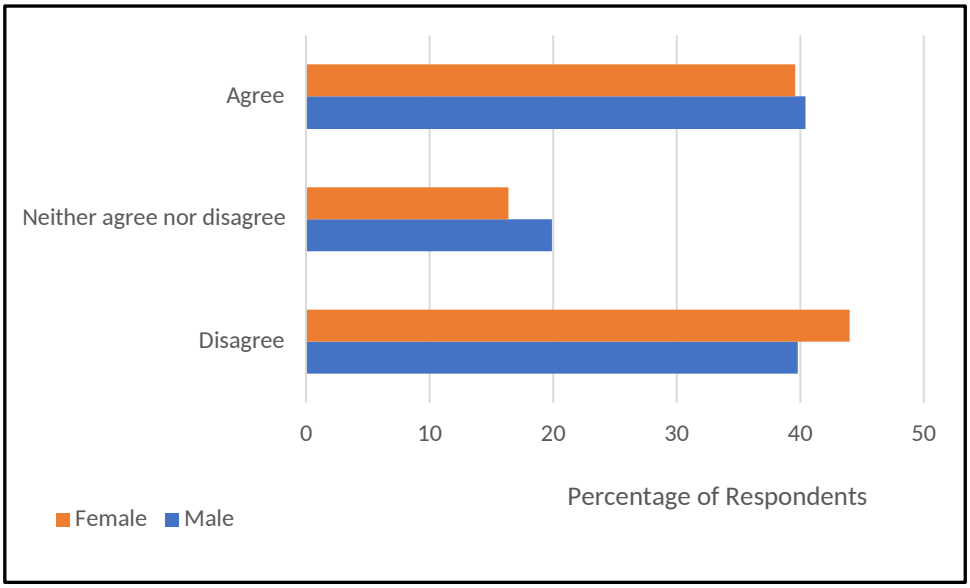
Agreement that Respondents Can Manage the Demands of their Position and Home Life, by Gender



When investigating ECRs' views about work-life balance with respect to managing the demands of their position and home life, again there is minimal difference. The results displayed in Figure 13 indicate levels of agreement are similar (47.2% men, 42.9% women agree) (Chi-square = 1.252, df=2, p= 0.535); the statistics show the levels of agreement are not significantly different.

Figure 14:

Agreement that the Work Schedule of Respondents Allows them to Maintain the Overall Quality of Life they Want, by Gender



When work-life balance is assessed with relation to quality of life there are similar levels of agreement between men and women. Figure 14 shows approximately 40% of participants agree that the work schedule allows them to maintain overall quality of life (men 40.4%, women 39.6%), and the p value indicates the difference is not significant (Chi-square = 0.556, df=2, p= 0.757).

Figure 15:

Level of Agreement with the Statement that Respondents Find they are Impacted by Inequitable Hiring Practices, by Gender

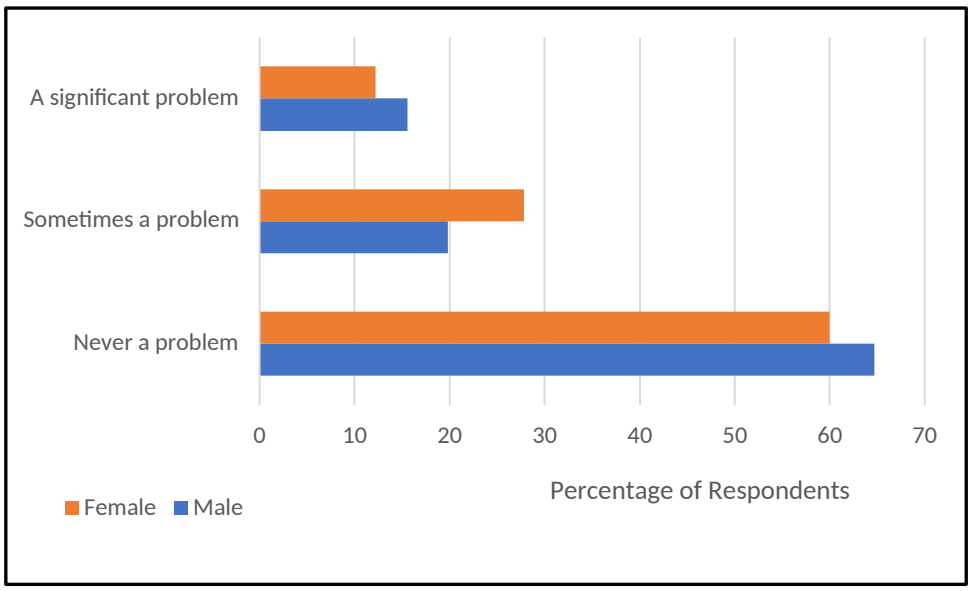


Figure 15 suggests men found inequitable hiring practices a little less troublesome than women. A total of 35.4% of men reported detrimental impact from these practices compared with 40% of women; while more women (27.8%) than men (19.8%) found it was sometimes a problem, more men (15.6%) found it a significant problem than women (12.2%). The statistics show these differences are not significant (Chi-square = 3.232, df=1, p= 0.072) although with the p-value between 0.05 and 0.1 there are indications of some gender differences.

This result, whereby men and women report statistically similar levels of impact from inequitable hiring practices, was unexpected. This quote, below, from on-line survey data provides evidence of the situation I had thought was likely to be common for many women:

> I am female with a young child, I do believe that this also impacts on my career, while there is no overt discrimination, people tend to assume I am happy

> taking a lower down less authoritative position, and think that I have less interest in career progression. (Survey respondent 334)

Areas where there are differences between men and women will be discussed in the following section.

4.3.1.1.4 Factors where Levels of Job Satisfaction were Different for Men and Women

Levels of satisfaction between the genders was not always consistent; in some respects, there were substantial differences between responses of men and women.

Given that the ECR period generally coincides with the time when ECRs start their families (Dunstone & Williamson, 2016; Smith, 2020; Wood et al., 2020), it was no surprise to find that more women than men were employed in part time work. Most men (85.9%) were employed 1.0FTE while 73.1% of women were full time (Chi-square = 14.995, df=6, p=0.020). When I investigated the number of hours worked each week, more men (21.0%) worked over 50 hours a week at work compared with 12.5% of women (Chi-square = 26.927, df=6, p=0.001); 45.5% of women worked up to 5 hours per week at home compared with 38.1% of men (Chi-square = 7.501, df=5, p=0.186). More women (52.1%) found their workload was too high compared with men (42.1%) (Chi-square = 7.18, df=2, p=0.027). These figures, which are all statistically significant as shown by their p values, probably suggest that women try to fit more into life and their part time positions while they balance children and work. It is very interesting that they remain just as satisfied.

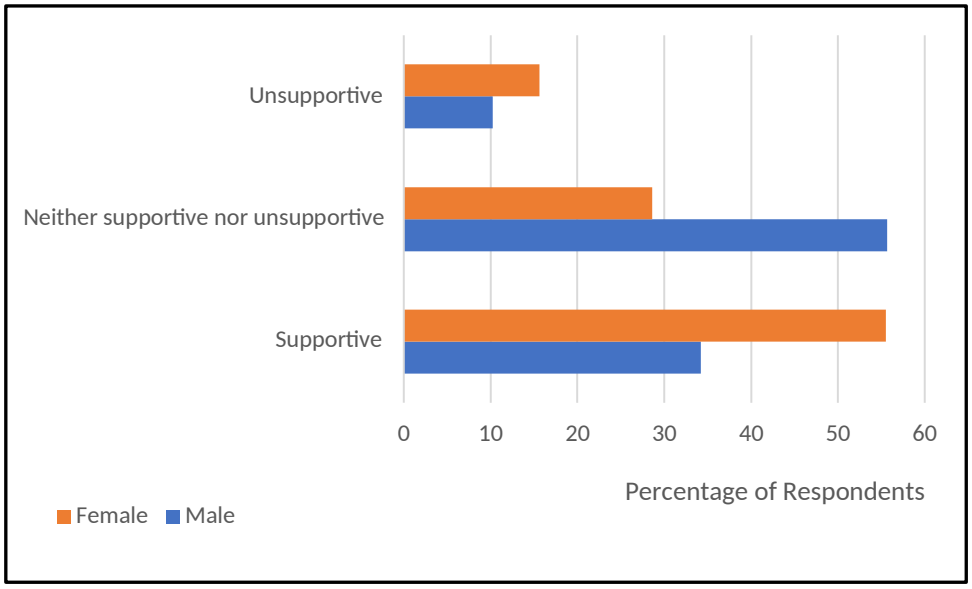
Misra et al. (2012) showed men and women (in USA) devoted significantly different amounts of time to housework and care giving. They showed that differences in work time were not simply split by gender, but by gendered parenthood, with mothers of young children

spending less of their work time on research than do fathers or faculty without young children. While male and female faculty devote the same overall time to their work each week, mothers of young children spent less time on research, the activity that counts most toward career advancement. More women disagree that they are able to achieve their desired quality of life than men in this on-line survey, this survey is consistent with the result of Misra et al. (2012).

I did not seek to explore matters relating to gender inequity in STEMM fields in great depth as there is much work being done elsewhere, particularly under the auspices of Science in Australia Gender Equity (SAGE) however it would be interesting to explore in further research whether this difference in time available for research for men and women is the same in Australia.

Figure 16:

Level of Agreement with the Statement that Respondents Find the Attitude Towards People of my Gender Supportive, by Gender



Many more women (56%) than men (34%) (Chi-square = 14.899, df=2, p= 0.001) felt the approach to people of their gender was supportive, as shown in Figure 16. The difference

is statistically significant. This suggests a possible reason for the findings of others (Moss-Racusin et al., 2018; Williams & Ceci, 2015) that there is unhappiness for men regarding the efforts to promote the welfare of women in STEMM. Indeed, there were comments to this effect in free text in the on-line survey.

> It seems practically impossible, in the current environment of amending previous generations' errors in gender balance, to get an Australian academic position in engineering-science as an Australian-born, Caucasian male (Survey Respondent 112)

This response from a woman highlights how, in her view, efforts for women are actually discriminating against both men and women:

> uncertainty around taking maternity leave [sic]. I am 30 years old and female. I have just commenced an accelerated academic position (assistant professor scheme). I am concerned about the impact that a career break would have on my academic career. This is a real concern for women and one that will not go away until men can be given the same paid parental leave entitlements as women so that my partner could potentially be the one to stay at home. At the moment he would get two weeks paid parental leave. I could get 33 weeks maternity leave. We have a home loan so the obvious decision from a financial point of view would mean that I would be the one to stay at home, but what if i [sic]want to go back to work? There is so much around gender equality but this is something that needs to be addressed. (Survey Respondent 293

Figure 17:

Impact of Harassment Based on Different Power Position, by Gender

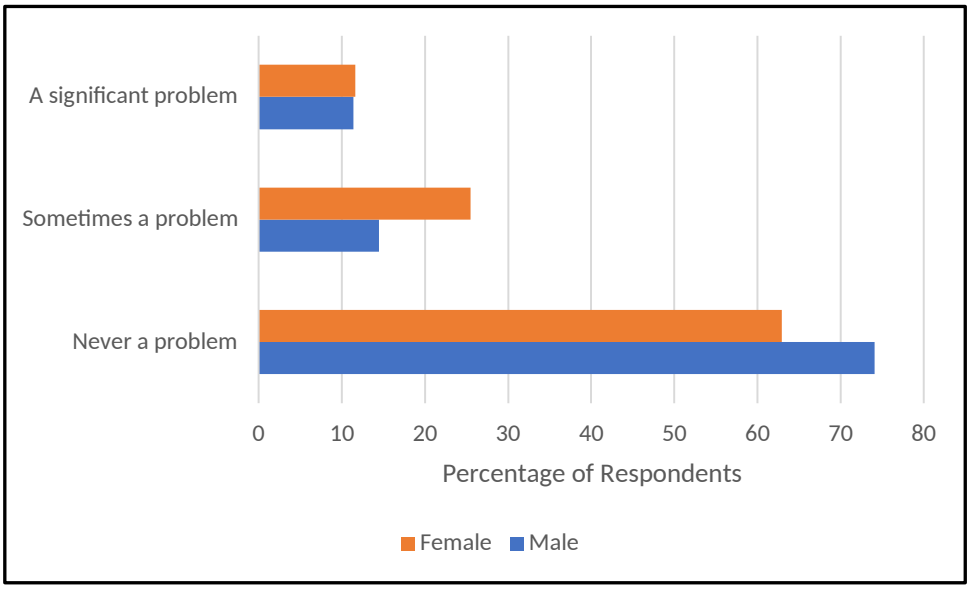


Figure 17 indicates more women (37.1%) than men (25.9%) agree they are impacted by harassment based on power position (Chi-square = 6.312, df=1, p= 0.012). Although the rate for "a significant problem" was almost the same for men and women, more women (25.5%) reported harassment was sometimes a problem than men (14.5%). This was no surprise as the qualitative data supported such findings.

As explained in Christian et al. (2020a), it is not clear from the responses to Q37-2 "To what extent have you or your career advancement been impacted by harassment based on different power position" what form this harassment took, however some descriptions of questionable practices can be found in the qualitative data and are reported in both that article (see Section 4.2.2) and in Christian et al. (2021) (Section 4.2.3). Some additional comments from participants are reported below.

> Please ask [in the survey] about bullying in university. It's an increasing problem, but a problem being talked about where before it wasn't. It is something

ASMR is focussing on. It's often a power struggle and gender problem (Journal, record of a conversation with female ECR)

I am currently looking outside academia to get away from the culture of harassment... it takes too much of a toll on my health... but I would stay in academia if I were to find a position that didn't subject me to harassment by a supervisor (female survey respondent 589)

[continuing] depends on overcoming harassment in current workplace (female survey respondent 589)

I do not think we are given any support with bullying and academic mobbing - it's hidden and unseen, especially when the perpetrators are other women academics. These women may look squeaky clean and have a high profile and seen [sic] on the surface to support other women, but the reality is sadly different. (female survey respondent 413)

There is also evidence of sexual harassment, as described below and in my interviews with women who had recently left academia in (Chapter 5).

My current workplace is great, however I was previously employed at The University [name] and had huge problems there with sexual harassment and bullying by a senior male colleague. After multiple complaints were ignored, I decided for my wellbeing to leave that job. I think sexual harassment in academia is an enormous issue and a huge barrier to female ECRs progressing in their fields and also staying in academia. I have also been told not to have a baby if I want to advance in my career by male supervisors, and while this is clearly wrong, there are not adequate supports in place to support parents to continue in academia, and the unstable nature of our jobs is also a huge deterrent (Survey respondent 578)

In a similar vein, I have recorded in my journal three situations reported to have taken place within one Australian institute:

- A female researcher told she might as well leave and go home to look after her children
- Another young woman told to put a retired male researcher on her grant to increase her chances of success
- A third young women told to make a young man, significantly more junior, ahead of her on the grant to increase her chances of success.

4.3.1.1.5 Findings for Job Satisfaction by Gender for People with and Without Children

As shown above in Figures 8 to 17 men and women have very similar levels of overall job satisfaction. In view of the literature which suggests more difficulties for women in STEMM (see Section 2.2.2.6) I explored whether or not having children at home made a difference to the level of satisfaction between men and women. Some of these findings are shown below.

Figure 18:

Level of Agreement with "Overall I Find My Work Rewarding", by Gender and With or Without Children

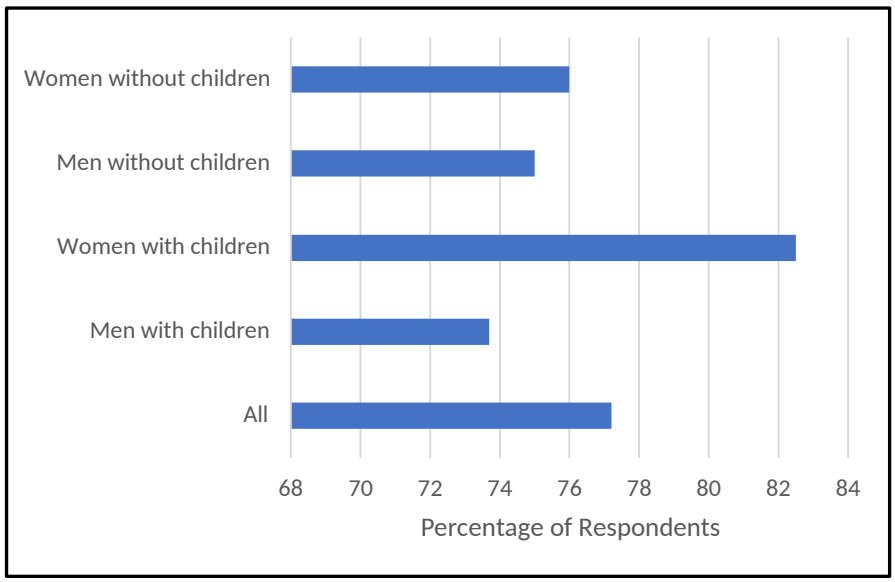
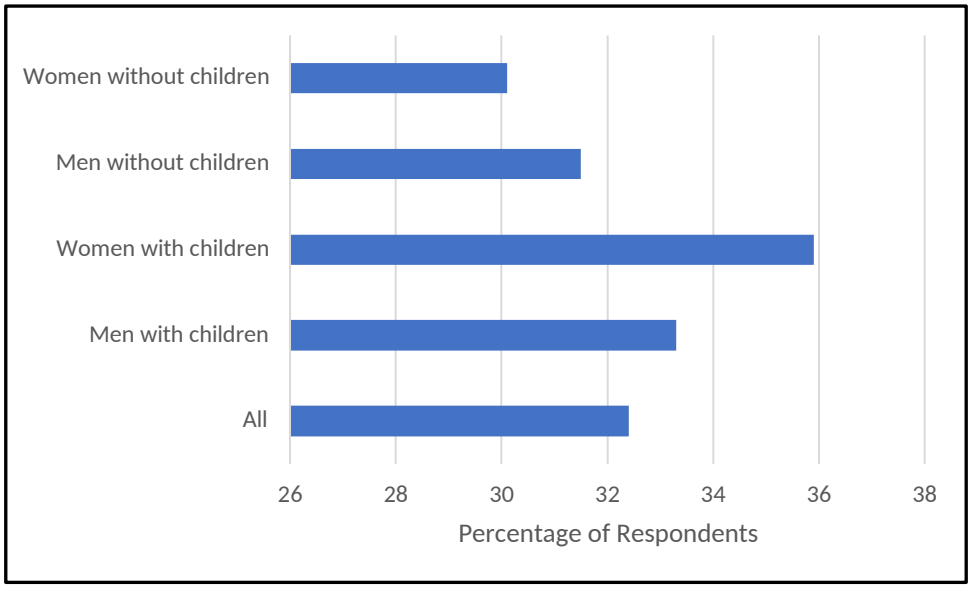


Figure 18 suggests that, proportionally, many more (82.5%) women with children find their work rewarding than do any of the other sectors; men with children are the least satisfied group (73.7%) (Chi-square =0.264, df = 1, p=0.607) however it must be noted the results are not statistically significant.

Figure 19:

Level of Agreement with " If I had to Do it Over Again I Would not Become An Academic", by Gender and With or Without Children



In an apparent contradiction to the answers shown above in Figure 19, a higher percentage of women with children (35.9%) agree they would not become an academic if they "had to do it over again" than people in other groupings by gender and children status (30.1% to 33.5%) (Chi-square =0.061, df = 1, p=0.805. Again, the differences are not significant.

4.3.1.1.6 Summary for Differences by Gender

In conclusion, there was little difference between the job satisfaction between men and women, other than women feeling less satisfied than men with the attitude to people of their gender and women being impacted by harassment based on power position. More women also reported their workload was too high, compared with men.

It appears that aside from the harassment issue (which is certainly a matter of consequence) the efforts to address gender inequity may be working well with respect to their influence on job satisfaction, as reflected by the answers for attitude to people of my gender,

and inequity with respect to promotion and hiring practices. These women appear to feel well supported, perhaps to the detriment of men. Recommendations relating to this situation can be found in Chapter 6.

4.3.1.2 Job Satisfaction by Years Postdoctoral

Responses highlighted differences in levels of agreement for various factors known to contribute to job satisfaction between people four years postdoctoral or less when compared with those five years or more postdoctoral.

Table 13:

Responses Showing Differences in Level of Agreement Between People up to 4 Years Postdoctoral and 4 Years + Postdoctoral

Q #	Question Detail	<=4 yrs % agree	>4 yrs % agree	Difference for more senior *	Stat Signif. p
31-13	I am satisfied with my workplace's commitment to a diverse and inclusive workplace	67.2	55.2	**-12%**	0.466
32-2	I am satisfied with the culture of my workplace	54.0	46.8	-7.2%	0.613
32-3	I am satisfied with the leadership and management of my workplace	53.4	38.4	-15%	0.257
36-6	I am satisfied with the attitude to people of my age	54.0	47.5	+6.5%	0.649
36-7	I am satisfied with the attitude to people of my gender	53.3	42.9	**+10.4%**	0.448
37-2	I have been impacted by harassment based on power position	31.1	36.7	+5.6%	0.599
37-3	I have been impacted by lack of support from institutional supervisors	54.1	67.5	**+13.4%**	0.413
37-4	I have been impacted by questionable research practices of colleagues within my institution	35.8	41.3	**+14.5%**	0.638
74-1	This is a poor time for any young person to begin an academic career in my field	58.5	73.2	**-14.7%**	0.399
74-2	If I had to do it all over again I would not become an academic	28.4	38.1	+9.7%	0.356
74-3	My job is a source of considerable strain	48.4	56.2	+7.8%	0.593
75	How would you rate your overall satisfaction with your current job (satisfied or very satisfied)	66.9	55.7	**-11.2%**	0.497

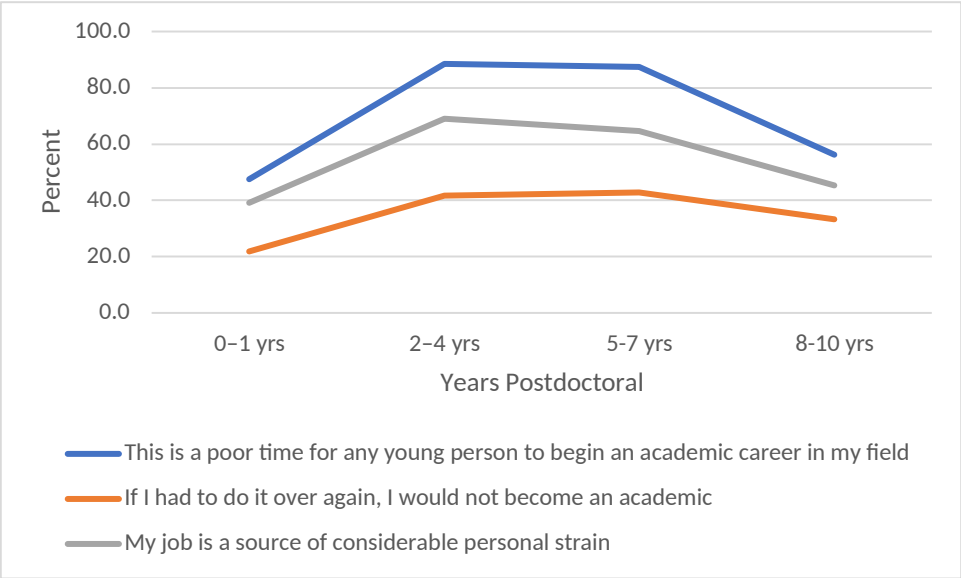
*** results with a difference of 10% or more are shown in bold**
n=328 for Q31-13 for <=4, n= 275 for Q75
n=280 for Q31-13 for >4, n= 194 for Q75

Table 13 shows responses where the difference in agreement is greater than 5%, however the p values show that none of these differences is large enough to be statistically significant. There is a consistent pattern however that those who were more than 4 years post-PhD were less satisfied than those who were 4 years or less post-PhD. Similarly, those who were more than 4 years post-PhD tended to indicate a higher frequency of being negatively

impacted by lack of support from institutional supervisors, questionable research practices of colleagues within their institution, and harassment based on power position and over 60% do not express satisfaction with leadership and management in their workplace. These more senior postdoctoral researchers more often indicated that this was not a good time to be in science and were less often willing to recommend science as a career; by this stage only just over half express satisfaction with their current job.

Figure 20:

Responses to Three General "Satisfaction" Questions by Years Postdoctoral



The line graphs in Figure 20 show consistent patterns in responses to three commonly used satisfaction questions cross tabulated by years postdoctoral. (The background to these three questions will be discussed in further detail in Chapter 5 (Section 5.2.2.3)). All three measures show a sharp decline in satisfaction after two years which remains steady to seven years and then they become more optimistic. Those who have managed to stay eight to 10 years must, to an extent, have made it to a greater level of job security so perhaps this explains why they are less likely than peers who have been in their positions for a shorter time to report “if I had to do it over again I would not become an academic”. These findings are

consistent with those of Miller & Feldman (2015)who showed postdocs reported greater satisfaction the more recently they had begun their first postdoc appointment ($b = –0.068$, $p = 0.008$), confirming that dissatisfaction increases over time spent as a postdoc.

These findings are also consistent with work discussed in Chapter 5 (see Section 5.2.2.3 onwards). Here I report modelling factors relating to intention to leave using the quantitative on-line survey data. The models find the most significant factor for intention to leave is number of years postdoctoral, followed by work related stress.

4.3.1.3 Job Satisfaction by Age

I next investigated job satisfaction by age and found there were a number of interesting trends. These are shown in Table 14 and illustrated in three line graphs on the pages following.

Table 14:

Responses Showing Differences of Between People in Different Age Groups

Q #	Question Detail	25-30 yrs	31-35 yrs	36-40 yrs	41-45	45+	All
		% agree or strongly agree					
31-13	I am satisfied with my workplace's commitment to a diverse and inclusive workplace	68.8	61.6	57.6	70.3	59.6	62.1
32-2	I am satisfied with the culture of my workplace	55.9	51.6	48.9	48.6	46.2	51.0
32-3	I am satisfied with the leadership and management of my workplace	53.8	49.6	39.6	40.5	48.1	47.1
36-6	I am satisfied with the attitude to people of my age (find supportive)	54.3	52.0	47.3	63.9	44.0	51.3
36-7	I am satisfied with the attitude to people of my gender (find supportive)	58.0	48.9	44.2	55.6	42.0	48.9
37-2	I have been impacted by harassment based on power position (a problem)	32.1	31.9	35.2	25.0	44.0	33.5
37-3	I have been impacted by lack of support from institutional supervisors (a problem)	53.1	58.6	63.3	61.1	66.0	60.0
37-4	I have been impacted by questionable research practices of colleagues within my institution (a problem)	35.8	37.8	36.7	47.2	40.0	38.1
74-1	This is a poor time for any young person to begin an academic career in my field	64.0	67.8	65.2	63.6	52.0	64.7
74-2	If I had to do it all over again I would not become an academic	28.0	31.7	38.4	33.3	27.1	32.3
74-3	My job is a source of considerable strain	52.0	51.8	50.9	60.6	43.8	51.4
75	How would you rate your overall satisfaction with your current job (satisfied or very satisfied)	65.3	63.8	53.6	60.6	72.9	62.3

Figure 21:

Responses to Satisfaction Questions by Age

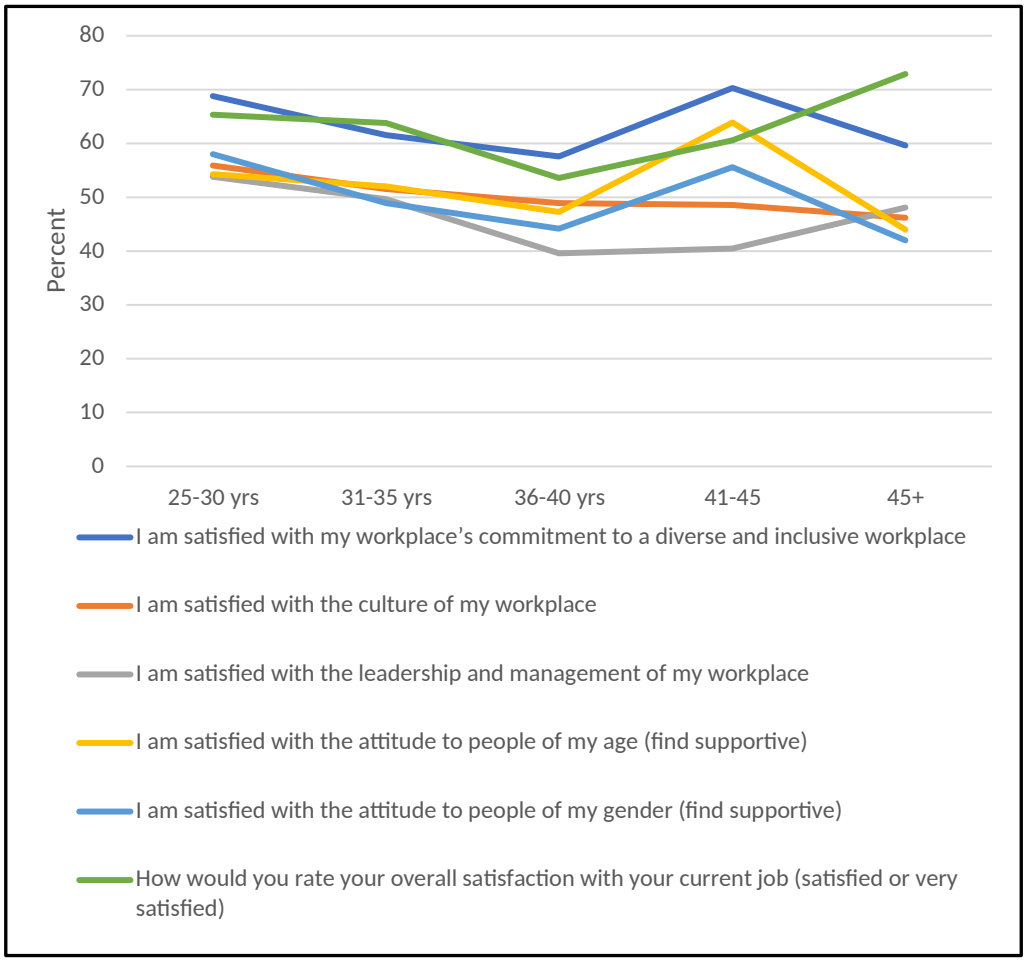


Figure 22:

Responses to Workplace Difficulty Questions by Age

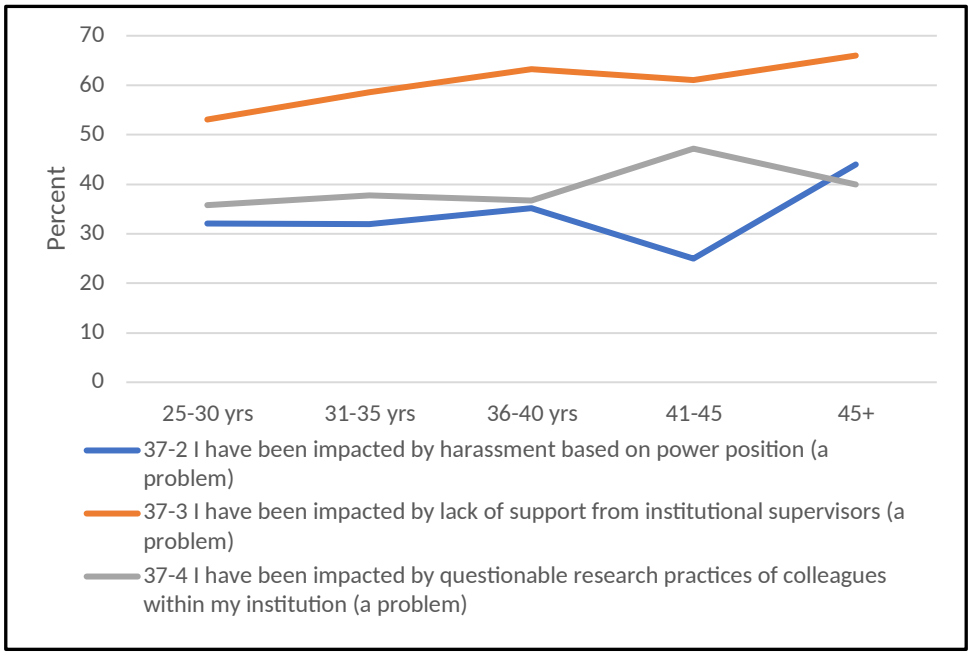
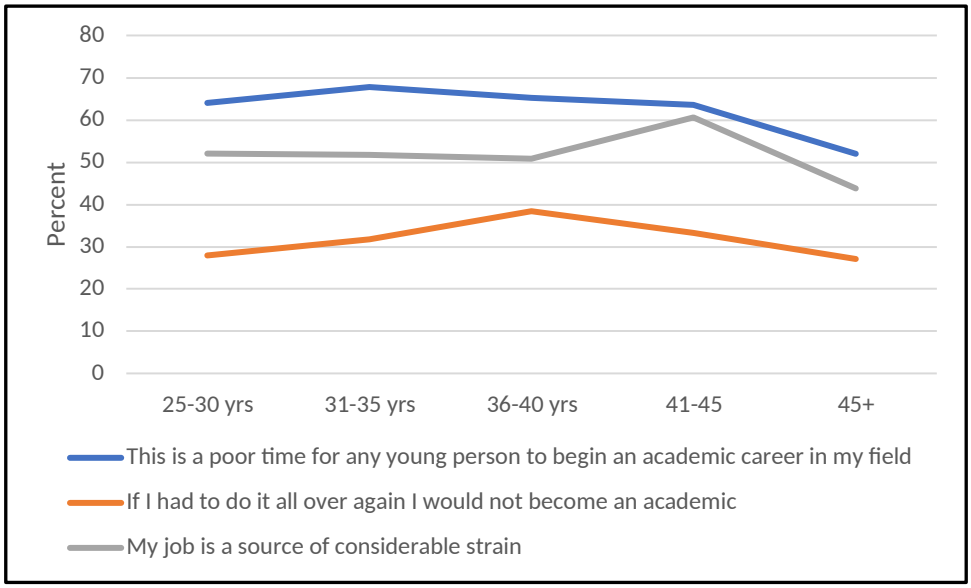


Figure 23:

Responses to "Big Picture" Satisfaction Questions by Age



The majority of on-line survey respondents were aged 30-40 (68%). People were increasingly impacted by lack of support from their supervisors as they grew older. At the

same time, unsurprisingly, they consistently became less satisfied with the culture of the workplace. The people who were most satisfied overall were the people who were over 45, however it is difficult to compare this group with the others confidently, as the age range could be very wide, and the other age divisions are five-year blocks. If this group is excluded from the trends, one can see a trend in dissatisfaction with leadership and management, a steady increase in personal strain and an increase in impact from questionable research practices.

Some older ECRs may be doing what they are doing electively, with their "eyes wide open", and many have become resilient however others feel they are victims of inequity as reported in the comments below collected in open responses in the on-line survey data:

> you have not covered ECRs who are actually late in their careers age wise [not actually correct – no age was specified]. We have unique problems with being accepted as worth employing because we are so experienced in other areas. Institutions do not want to take on people such as we. This problem is not recognised, nor is it being dealt with adequately. It is a huge loss of experience to Australia (Survey respondent 72)

> There is an underlying assumption that ECRs are "young". I know many who have taken on an academic career as a 2nd career, including myself. (Survey respondent 797)

> I am an ECR but am not 'young'. I left an established career to retrain and complete a PhD - and how I wished I hadn't. The jobs are simply not there, and those that are there are limited and sooooo competitive. I don't want to live wondering if I will have a job next week, especially after changing careers mid working life. Academia has a lot to answer for. (Survey respondent 666)

4.3.1.4 Job Satisfaction by Work Type

There are quite marked differences between the experiences of people working in research-only positions compared with combined research and teaching roles, teaching-only roles or combined research and clinical roles, as illustrated in Table 15.

Table 15:

Differences between Various Measures of Job Satisfaction for Different Job Types

Nature of Work	University teaching only (n=10 to 14)	University research only position (n=258 to 336)	University combined teaching & research position (n=110 to 146)	University & hospital, combined clinical & research position (n=19 to 24)	All (n=397 to 520)	Stat Signif p
Question Detail	**Percent Agreement**					
Q75 How would you rate your overall satisfaction with your current job (satisfied or v satisfied)	70	64	59	84	63	0.71
Q74-2 If I had to do it over again I would not become an academic (agree or strongly agree)	60	29	32	21	30	0.031
Q73 How does your job as an early-career scientist meet your original expectations (better or much better)	0	14	13	16	14	0.004
Q31-4 Overall I find my work rewarding (agree or strongly agree)	77	79	77	80	78	0.999
Q20 How would you describe your overall workload (too high)	57	41	64	63	49	0.552
36-1 have an unreasonable amount of administrative work (agree or strongly agree)	46	35	69	40	42	0.219
Q41-2 My work schedule allows me to maintain the overall quality of life I want (agree or strongly agree)	36	44	34	32	40	0.831

Table 15 shows the levels of job satisfaction between people with different job types. The p value shows that these differences are not statistically significant other than for Q73 How does your job as an early-career scientist meet your original expectations however as

this question has a zero answer for the very small group of people who are teaching only, it is unlikely to be reliable.

Noting that the majority of the differences are not statistically significant, I pose interpretation of the data. The job satisfaction of clinician researchers (a small sample n=19 to n=24) is markedly higher (84%) than for other categories. Clinician researchers also feel they have the highest workload, along with combined teaching and research but the plus side is they feel they have the highest job security (though still only agreement of 50%). People in research-only and teaching-only positions have a dismal view of their job security; this can be explained by the much more secure, and longer-term contracts which are available to people in combined teaching and research positions. Counter-balancing the benefit of this security, the figures reflect the high burden of administrative work.

People in teaching-only positions (a small sample, n=10 to n=14) would be least likely to do the same job again and none felt their job had exceeded expectations though this number was low in all categories. People in research-only positions are least likely to agree their workload is too high and, although level of agreement is not high for any categories, people in research only positions agree more than others that their work schedule allows them to maintain the overall quality of life they want. In spite of all these figures which could be expected to predict low numbers, in all categories the respondents find their job almost equally rewarding and do so at a very high level (77%-80%).

Both the manuscript Christian et al. (2021) and my review of the findings regarding impact of organisational support (or lack of it) which is discussed below (section 4.3.2.6) show there were differences in impact of lack of support from institutional superiors (much higher for clinician researchers). Those in research-only positions were more likely to report impact of questionable research practices and feeling unsafe at work than clinician

researchers, or people in teaching or combined positions, suggesting that increased time in the overly competitive environment may increase the frequency of exposure to inappropriate behaviours.

All this confirms the views expressed elsewhere (Gascoigne, 2012; Wellcome Trust, 2020) that ECRs in STEMM fields find their work rewarding while being dissatisfied about working conditions.

It was disappointing that I recruited so few clinician researchers as this is a group of people whose translational work is of great value to medical research (Butler, 2008; Noble et al., 2020). Personal observations made during my work in medical research, including reflection on conversations in my journal, suggests there are many difficulties faced by young clinician researchers, particularly as there is an expectation that they will conduct their research in their own time, and often at their own expense, or else they will take substantial periods away from clinical duties to undertake a PhD. These observations support the literature that shows these young clinicians believe that without a research record it can be difficult to progress within some specialties (Eley et al., 2017). There is certainly an opportunity for further research into the experiences of this valuable cohort.

4.3.1.5 Job Satisfaction by Country of Birth

There was minimal difference between answers about challenges from respondents who are Australian born compared with people who are born elsewhere as illustrated in Table 16.

Table 16

Responses to Questions Relating to Satisfaction by Comparing Australian-born Respondents and People Born Elsewhere

	Question Detail	Australian born	n	Not born in Australia	n	All	Stat signif p
36.8	I am satisfied with the attitude to people of my ethnicity	48.7%	263	44.2%	249	46.4%	0.737
31-4	Overall I find my work rewarding	78.0%	287	76.4%	271	77.2%	0.933
32.2	I am satisfied with the culture of my workplace	53.0%	287	49.3%	270	51.0%	0.797
37-2	I have been impacted by harassment based on power position	32.7%	263	34.4%	249	33.5%	0.872
37-3	I have been impacted by lack of support from institutional supervisors	63.5%	263	55.6%	247	59.8%	0.625
37-4	I have been impacted by questionable research practices of colleagues within my institution (a problem)	36.1%	263	39.7%	247	37.1%	0.755
32-3	I am satisfied with the leadership and management of my workplace	48.8%	287	45.9%	270	47.1%	0.830
74-3	My job is a source of considerable personal strain	56.2%	242	45.9%	220	51.6%	0.473
75	How would you rate your overall satisfaction with your current job (satisfied or very satisfied)	65.2%	242	59.5%	220	62.3%	0.733

Table 16 shows the differences in responses between people born in Australia compared with those born elsewhere. None of these differences is statistically significant.

Noting these differences are not statistically significant, and that observations must be taken with reservation, it is not surprising that the figures suggest those not born in Australia were a little less satisfied with attitude of people to their ethnicity as in many cases they must feel themselves in a minority and somewhat vulnerable. The other exceptions where there appears to be a difference were a lower incidence reported by the people not born in Australia of both impact of lack of support from institutional supervisors (55.6% compared with 63.5%) and of finding their job a source of considerable personal strain (45.9% compared with 56.2%). In spite of this, those born overseas report a lower job satisfaction (59.5%) than their Australian-born colleagues (65.2%) while they find their overall work slightly less rewarding

(76.4% compared with 78%). Given that respondents self-selected, a limitation for this query could be that people with poor English were less inclined to take part in this on-line survey (although I did include people from non-English speaking backgrounds in the pilot survey to ensure it was sufficiently clear for them). Likewise, people from other cultures might be less inclined to express their views than native English-speakers.

4.3.2 Further Findings for Some Individual Factors Contributing to Job Satisfaction

As discussed above, it became clear from my findings that the most influential factors found to contribute to job satisfaction (or lack of satisfaction) for Australian ECRs in STEMM were job insecurity, years postdoctoral, workplace stress and lack of work-life balance, family situation, the need to relocate, lack of institutional support and questionable research practices. I discuss some of the individual factors in detail in the following sections.

4.3.2.1 Job Insecurity

As has been explained previously, lack of job security was the over-riding factor contributing to the workplace environment for ECRs and job security was therefore selected as the external constraint for the model. The nature of the short-term contracts means that many ECRs have to move jobs, institutions, states and even countries regularly. They will go anywhere they can find a job.

There are fewer and fewer permanent research-only jobs in academia in Australia (Walton, 2016); I was told there are now none at one Go8 University, renowned for its scientific work (personal communication recorded in my journal). Researchers, even researchers in very senior positions, are dependent for their salaries and research expenses on grant funding which they must source themselves or with collaborators. Once that funding runs out, they and their teams are immediately vulnerable. While there are permanent

positions to be found in other scientific career paths such as industry, government or science communication, the journey to alternate careers is widely regarded as being a "one-way street", and one which places substantial restrictions compared with the freedoms to be found in academic research (Åkerlind, 2005; Payne, 2019). Transition to the pharmaceutical industry, for example, is often regarded as being a trip to "the dark side" and one to be resisted.

> I think something I had here in Australia is that sense of if you're speaking to someone outside of the system and you say you work for a pharma company, I feel that they look down on you. Whereas if you say you work for a university, they hold you up on … a pedestal. (Interviewee Cecile)

> Definitely not. No I wouldn't work for a company – like a drug company – I couldn't do that - no. (Interviewee Daisy)

> Industry has a very bad stigma attached to it (Interviewee Margaret)

It appears that ECRs are viewed within their institutions as resources readily replaceable from the next crop of PhD students, rather than as individual people, and there is little concern for the ECRs who lose their positions after only a few years. This situation has been described for ECRs in other countries including the UK (Capewell & ECR Subcommittee, 2017) where an ECR members' survey showed the majority of respondents (84%) reported they have unstable careers with short-term contracts and are fighting to survive in competitive institutions. Capewell et al. found that in most institutions, academic value was measured in terms of outputs, rather than in development of skills or acquiring responsibility, supporting the proposition that the ECRs are regarded as resources.

There were many free text comments in the on-line survey which reflected the consequences of lack of job security:

> I am here for two years. One year in, there's isn't time for focus on research - just what is going to come next year. It's incredibly debilitating mentally. (Survey respondent 375)

> At the beginning of this Postdoc position, I was offered a 2 yr contract but when it was over, I have been rolling 3 months contracts. This is my third 3 month contract and I am really tired of living in suspense, if I am going to be hired again. Supposedly all is due to the lack of funding in the group but sometimes it seems it is due to the preferences my boss has. (Survey respondent 826)

4.3.2.2 Years Postdoctoral

As was shown when measuring job satisfaction by years postdoctoral, the on-line survey results show there is a definite decrease in job satisfaction for people five to 10 years postdoctoral compared with the earlier years. I expect the ECRs become tired and lose their resilience. These findings are supported by qualitative data as shown in the comments below:

> I thought I could tolerate the uncertainty, long hours and pressure and I can, but I no longer think it's worth it to do so (Survey respondent 880)

> For most of us following the academic path, the point of our lives at which we begin to start families, take on mortgages, and start to want to put down roots corresponds with the beginning of the mid-career gap (5-10 years post-PhD) at which point ECR support dries up completely and any sense of job security is long gone (unless you are very lucky). **I would never ever recommend this career to anyone who wants to know where they will be living and working in 3 years time. It is a source of great strain on relationships and stress in the lives of many young researchers.** But, that's how it is in science, isn't it? (Survey respondent 763) (emphasis added)

4.3.2.3 Workplace Stress and Lack of Work-life Balance

Workplace stress has been discussed throughout this thesis and has emerged in many guises in the on-line survey findings. It can be seen from the qualitative data that the workplace stress of ECRs is closely linked to job insecurity:

> Academia is full of ECRs with mental health problems as a result of a lack of job stability and excessive work hours- having "publish or perish' whispered into your ear everyday is very detrimental and I would not recommend academia to anyone starting out (Survey respondent 676)

> I have often contemplated moving completely away from academia, science and become a gardener or something. The stress related to lack of funding primarily, but also publishing demands and general negativity/adversarial competition in academia can sometimes become too much and really effect one's mental health. (Survey respondent 630)

One can hardly imagine the stress which must be felt by the ECR who made the comment below and who is balancing multiple contracts to hold a "job" together:

> At one point in my first year post-PhD I had two fixed-term contracts (0.5FTE and 0.2 FTE) and three-four casual contracts. Trying to manage the workload across so many different projects plus teaching was awful (Survey respondent 110)

Regrettably, I agree with the following comment, which is a poor reflection on our academic institutions:

> Mental health of ECRs is overlooked and the universities treat us as second class employees that are disposable. (Survey respondent 864)

These ECRs work very long hours which must contribute to their stress and lack of work-life balance. Of those engaged full time, 57% work more than their allotted 40 hours at work and 73% work up to 10 additional hours at home.

Figure 24:

Hours Worked at Home for Those Engaged 1.0FTE and Working More than 40 hours per Week

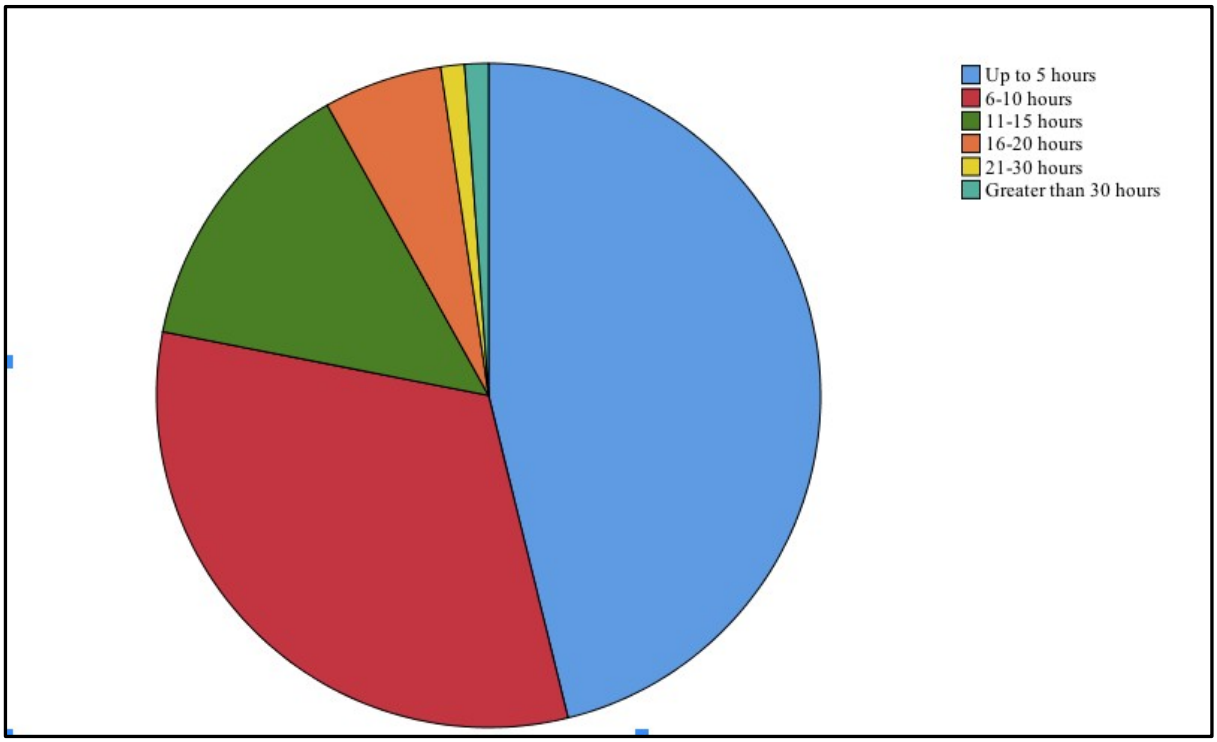


Figure 24 shows the hours worked at home for those who exceed a 40 hour week at work. It is no surprise that 50% think their workload is too high.

Of those engaged 0.6FTE (24 hours per week expected), 85% worked more than 20 hours at work, and all worked at home as well, with 72% doing 0-10 hours and the rest more than 10 hours. Of those engaged 0.5FTE (20 hours per week expected), 81% worked more than 20 hours at work, and again all worked at home as well, with 81% doing 0-10 hours.

Sixty-three percent of 0.5FTE staff felt their workload was too high, as did 62% of 0.6FTE staff. (I note these are from small samples (n=26 and n=16 respectively)).

Two thirds of these 0.5FTE workers and 44% of the 0.6FTE were parents of small children; one from each group had the care of a family member with a chronic health condition. It is likely that all, whether with caring responsibilities or not, were working on papers and grant applications at home in their "spare" time.

4.3.2.4 Problems for Parents of Young Families

Again, the need for work-life balance and the particular difficulties of parents of young families have been discussed previously. They have each emerged from the quantitative data as factors contributing to job satisfaction (or lack of it), and this is supported by the qualitative data:

> I did not anticipate the amount of opportunities that become unattainable when trying to manage a young family and a career in science. How does one compete for fellowships again [sic] others of similar experience that have not had any career breaks? Also once you return to work, usually part time when still caring for young children, it becomes near impossible to generate first author manuscripts and there is little/no appreciation for middle author manuscripts (Survey respondent 298)

> Work life balance is extremely difficult. Multiple deadlines, being spread too thin across too many activities (teaching, research, service, admin, etc) makes it very difficult to feel 'on top of things'. Having to catch up on emails/work at home with a young family to care for is extremely stressful. I believe expectations of modern academics and the competitiveness in academia are unsustainable and

> make it very difficult to juggle personal and professional success/satisfaction (Survey respondent 778)

I am alarmed to see, in this day and age, when the law should protect women on maternity leave wanting to return to work, the type of inequity demonstrated in the quote below:

> Contract expired while I was on maternity leave, and there was no funding for extension or new contract. (Survey respondent 747)

In a similar vein, I am aware of a young woman (personal communication 2020, name withheld) who has been asked to return a substantial portion of her funding to the granting body, in spite of her meeting and exceeding all aims, because she took maternity leave during the life of the grant. The quote below sums up the problem for ECRs wanting to have children:

> One of the biggest challenges is the interaction between wanting to have a career, wanting to have a work-life balance, and wanting to have children right at the time at which my career is at a pivotal point. (Survey respondent 593)

As mentioned above, the needs of the young family typically come at the same time as the ECR is reaching a crisis point in their research. The pressure to publish and attract funding leads to long hours and the lack of work-life balance. They are stuck in a vortex, though they tend to keep on trying, as revealed below.

> I accepted my short-term contract 0.8 FTE job with the expectation that I could use the 0.2 left over for my research (without pay), but my teaching workload quickly enveloped this. Without enough time to research and publish, and no job security beyond 1 year, it is hard to see any possibility that I will be able to stay in research at the end of this contract. I believe my experience of

> teaching commitments pushing out time for research/publication (and therefore possible career advancement) is relatively common. (Survey respondent 141)

This extra work they do for their grant applications and publications to support their research gives them hope for the future but does not benefit them in the immediate term – and of course may not benefit them in the long term either. There is no extra pay for all the extra hours they put in:

> Although we don't get paid for extra hours of work most of the supervisors expect us work extra time for free. This is an unavoidable situation for any post doc as we depend on them for next contract. Due to this situation there is a huge imbalance between work and personal life and lot of stress. Please recommend to the government to make appropriate regulation on this issue. Please ask the questions like how hours each post doc will spend time with there [sic] kids and family. (Survey respondent 906)

There are some difficulties which could be readily rectified by the institutions. Reflections recorded in my journal show that training opportunities are often still held outside core office hours, which poses problems for people with young families. At one major research institute, renowned for its progressive views for assisting women, the Director appears not to have noticed that having "the door open for anyone to come for a quiet chat" between 7 and 8am might not suit those with family duties, or that as Friday night drinks with the team events are only attended by men, women might be feeling excluded (personal communication, recorded in my journal). The following comment supports the existence of the same sort of situation elsewhere:

> I feel like there are many opportunities provided by my institution for further learning, training, mentoring etc but with two small children at home, I am

> not able to take advantage of these, as they often [sic] outside of my working hours. (Survey respondent 452)

Another matter often mentioned which particularly pertains to parents of young families is the difficulty of fitting the required work into a part time job. This problem is not confined to science, but in other jobs it would be unusual to have to work in order to attract funding for one's own salary.

> I find a never ending struggle between being able to spend enough time at work getting everything done and ignoring my 3 children, to being able to be there for my children and feeling like I'm not doing enough at work. Now with children moving into school, it would be of benefit to have a stable job where I'm not constantly having to apply for funding to keep my position alive for another 6 months, another 3 months, another year here and there. It is stressful not having that job security but working so many hours (more than my paid FTE) (Survey respondent 234)

> Now that I have a family I would only like to work part-time for the next 5-10 years but it is very difficult to stay in the research game working such few hours. (Survey respondent 88)

The findings of Myers et al. (2020) and Johnston (2020) about the unequal effects of the impact of COVID-19 provide current evidence that female scientists and scientists with young dependents are markedly restricted in their ability to devote time to their research; the impact is most pronounced for female scientists with young dependents.

In the next section I present a further challenge which particularly impacts early-career researchers: the need to relocate to further their career (or, sometimes, to continue it at all), and which may well impact those parents of young families described above.

4.3.2.5 The Need to Relocate

Another difficulty which often impacts family responsibilities is the perceived need to re-locate to gain further experience (as opposed to relocation just to have a job). This is a long-standing practice, mentioned in Christian et al. (2021), and by Gascoigne (2012) of recommending, sometimes insisting, that ECRs should spent a few years in an overseas research environment to further their experience. The culture has not changed with the times, and even though in this era it is likely that both partners will be in the workforce, ECRs find they must move several times in their early years in order to progress leading to considerable distress.

This topic is worth including here as it is a difficulty probably largely confined to those in STEMM disciplines from countries distant from the rest of the world, like Australia. While the experience gained is reported to be very beneficial, it appears to bring with it very high levels of stress and personal inconvenience as reflected in some of these comments:

> Personally very costly and time consuming, but necessary for career advancement and to stand myself apart from other candidates (Survey respondent 92)

> Starting from scratch with a whole new group of colleagues who don't know you and struggling to find research momentum in a new institute, city and country, all of which is very different to previous places you've lived before. Everything is done differently and you're constantly learning the hard way, which takes time and significantly eats into your research progress. It's also lonely and can inhibit the development of long-lasting professional [sic] and personal relationships because you have no idea how long you'll really be in the country. (Survey respondent 303)

Along with this moving in order to benefit career progression, moving to wherever there is a job is very common. This consequence of short-term contracts and general job insecurity often leads to spouses being separated or people being away from wider family support.

> Living remotely from my husband (long-distance) and in a different country than my immediate family (siblings, parents) creates a very isolating experience. (Survey respondent 391)

> Moving cities/countries has always major impacts in one's life. My last move meant that me and my partner had to live in different cities (which were more than 5 hours flight apart) for more than one year. When I decided to quit and move back to where my partner was, I stayed unemployed for a while (and working outside Academia) until I managed to get a job in research again. (Survey respondent 256)

There were several comments from people who had chosen not to make a move, or another move, and the consequences were not worth the advantages:

> I have moved between research groups and institutes within the same location. The most significant impact was to create new collaboration and extend my network. **I purposely did not change location because of my family responsibilities. I believe this may be seen a weak point now** in apply [sic] for grants, fellowships, promotion, new positions etc despite the fact that I already came all the way from [country] to do my PhD in australia [sic]. I often feel like I am now expected to pack up and go somewhere else again, just to get a good line on my CV. no [sic] thank you. (Survey respondent 557) (emphasis added)

4.3.2.6 Lack of Organisational Support

Lack of organisational support takes many forms, and it appears that many institutions neglect their responsibilities for ECRs, failing in duty of care. I describe some instances typical of lack of support below.

4.3.2.6.1 Poor Supervision

As described in Christian et al. (2021), 60% of on-line survey respondents reported impact on themselves or their careers from lack of support from superiors. This is a very high number. Although the ECR period should be treated as a training period, and indeed the Australian Code of Responsible Research Practice requires appropriate supervision of research trainees, the ECRs are often left to their own devices to "sink or swim" (Browning et al., 2016; Dolgin, 2017).

> I've had to work out the systems for myself, the rules for myself and they're just lucky that they've got someone like me who's just like, 'Right – I'm going to ring the person…I've basically been dropped into it nobody's come to ask how I'm going'. (Interviewee Tania)

Either the supervisors are either too busy to support their teams, or the culture does not require them to do so, and the supervisors have never been trained for being supervisors. Often the ECRs really do have to work it all out for themselves. It seems some have no supervision at all:

> Was employed as postdoc and my supervisor was MIA for the 3yrs- I think this really hindered my research output and professional development. (Survey respondent 205)

> I thought that there would be more support and development opportunities. Instead I feel that I have been thrown into the deep end and expected to take on too much. (Survey respondent 132)

> I have to apply for grants, but noone has ever shown me how.- I feel utterly unappreciated, unfulfilled and extremely isolated. I used to be part of a large lab group as a PhD. Now I'm stuck largely alone, I won't know if my grants were successful for months - hence there's no feedback on my work, or sense of achievement and I feel very unfulfilled (Survey respondent 280)

Poor supervision extends to failing to hold regular performance reviews, accepted best practice in the "outside" world (Dorsey & Mueller-Hanson, 2017). Thirty two percent of on-line survey participants reported they had not had a performance review in the past two years. While in some cases this would be because they were on short term contracts, it is reasonable to expect everyone deserves to be reviewed and to participate in a discussion about their work with their supervisor. The comment below from the focus group discussion (supported by others in that group and by first-hand reports I have recorded in my journal) shows that the performance reviews are often actually fabricated to defy the HR system:

> We have – our university has like an annual performance in development – like an official thing that we have to complete and we're supposed to discuss with our supervisor and in my supervisor's case, he's got a lot of people and generally these meetings don't happen. **So it's like you fill it all out and it's all down on paper but in reality we're actually not having those conversations** very often at all. So it's just down to tick the box 'cos it's a requirement by the institute. But he sees it as a waste of time. (Interviewee Valentina) (emphasis added)

4.3.2.6.2 Lack of Mentoring and Training

There is a disappointing number of ECRs (38%) who do not have a mentor (defined in the questionnaire as someone who is there to assist you achieve your personal, academic and career exploration goals; not necessarily your supervisor.). Some respondents reported they had to pay for mentoring:

> I have a mentor that I pay for as no-one was really offered to me via my work. (Survey respondent 413)

> Paid professional coach through previous workplace (Survey respondent 688)

Austin (2007) wrote about the results of a survey following a feature on Lab Management in Science which asked people whether they had received lab-management training. This survey (from 27% PIs and 40% postdocs, 25% grad students, 6% other) showed that 86.6% of respondents had never received formal training on managing people, and 91.5% of people had no formal training on managing money. Citing this survey, the frivolous blog "The Business of Running a Lab" (ilovebraaains, 2012) wrote, quite correctly, that running a lab is a lot like owning a business, and that many of the skills needed to succeed in business can be applied to science. This blog suggested three very sensible reasons for the resultant problems:

- You are expected to learn lab management from your PI, not in class
- PI's don't get credit for teaching lab management skills
- The teachers don't have training

Perhaps there should have been a fourth point: the teachers don't offer training. More recently (Van Noorden, 2018) wrote about the same issue: "we take people with no management or leadership training and tell them to run a team of 3–20 people and assume they should just know how to interact and how to manage others" (p.296).

Poor supervision, or perhaps lack of supervision, of the nature reported, probably permits the reported inappropriate behaviours and questionable research practices to creep into the workplace culture. My data shows the institutions fail further in their duty of care by not addressing the culture where bullying and harassment are commonplace (33% respondents reported they were impacted by harassment based on power position) and there are 12.5% respondents who report they do not feel safe at work.

> And it's really hard to argue with them because (a) they're in a position of authority over you – so it's an intimidating thing. I've had times where I've had to have arguments to try and get what I feel like I deserve on papers because I feel like someone's bullying their way in when they shouldn't be (Interviewee Hilary)

4.3.2.6.3 Excessive Administration

Many of the ECRs (40%) feel over-burdened by an unreasonable amount of administrative work. This quote from the on-line survey's qualitative data provides a clear picture of poor organisational support and few rewards for effort:

> what I do not like is the lack of supervision, mentoring, guidance, the marked preference I see my boss has for some male members of the lab, the lack of funding opportunities, the lack of job security and that in this job you have to do everything, you have to come up with ideas to apply for grants, to get funding, then you have to do the experiments, you have to do the data analysis, you have to manage the lab, order consumables, manage budget, mentor students without

> being the official supervisor, then publish the paper but your boss is the main author and when you finish all that, do it again. Being a postdoc is not a job about research, is about being plenty of things more and then be expected to keep on doing more things for the same money and little recognition, without any job security. (Survey respondent 826)

4.3.2.6.4 Postdocs are Required to Do the Work of Research Assistants

An interesting change in the research environment in recent years has been employing ECRs to do work which would once have been allocated to research assistants (RAs). There are now very few administration positions (if any) to support the researchers. There were several instances where ECRs mentioned that they were doing the work of research assistants in Q77 "is there anything else?", and others who wished they could have research assistants or more support staff/admin staff (i.e. RAs) in "Other" responses to Q33 "if you could change one thing", thus presenting the other side of the story.

> It's a fairly common cry that people are using – well the youngest postdocs - to do the admin because there's nobody else to do the admin. It's putting a lot of education into running around pieces of paper isn't it? (Focus group participant Josie)

This is good for the new ECRs (not so good for the RAs) who get a start where they want to work, but as seen in the comment below the ECR soon becomes too expensive. This is when many lose their position.

> Since I've been back in academia (2.5 years now), I have been much happier and draw much more value from it. I've only been doing research assistant work but I feel valued and I'm given a great deal of autonomy. I would happily

> work at this level for years to come except I know eventually I will be too experienced and too expensive. (Survey respondent 890)

This view is consistent with those expressed by others (Bogle, 2018; Pain, 2014) that ECRs provide the engine room for grants and papers. The ECRs are highly educated and keen to work. They work very hard for a few years, then leave when there is no longer a job offered because they have become too expensive.

4.3.2.6.5 Research Resources

The questions in the on-line survey were not designed to fully evaluate views about overall resources for research, a factor described in the literature as being a factor contributing to job satisfaction, but out of scope for this study. While lack of funding for salaries is a huge issue, the on-line survey asked only restricted questions about resources for research. There was no commentary about resources or lack of resources collected in the qualitative data. Table 17 shows responses to some relevant questions.

Table 17:

Responses to Questions Regarding Satisfaction with Research Resources

Question Detail	Percentage
Q30 Do you have adequate funding to carry out your research (agree)	54.7
Q31-9 I have adequate equipment and resources to do my job (agree or strongly agree)	62.9
Q32.4 Satisfaction with opportunities for attending conferences and study leave (satisfied or very satisfied)	60.5
Q32-5 Satisfaction with support for career development/professional development (satisfied or very satisfied)	55.9
Q32-6 Satisfaction with level of resources and equipment to do my job (satisfied or very satisfied)	65.5

The responses to questions about research resources show a reasonable level of satisfaction. I now move on to discuss aspects of the research environment, questionable research practices and a perceived lack of understanding about possibilities for alternate careers, which have given greater cause for concern.

4.3.2.6.6 Questionable Research Practices

There are consequences of poor job security and an over-competitive environment; it appears that research ethics can be at risk in our STEMM workplaces. In a 2014 article in Nature the editor reported on two major surveys conducted in the UK and US which showed that researchers felt so overwhelmed by their positions that they were tempted to compromise their research integrity ([Editor, Nature], 2014) This view has been supported by others including (John et al., 2012) and, more recently, Hofmann et al. (2020) and Wellcome Trust (2020) and by this and other comments:

> what they wanted to see result-wise wasn't what I was seeing. And so I was being accused of misconduct because I wasn't seeing what they wanted me to see, and I wouldn't change that (Interviewee Nick)

Our Research Ethics Monthly article (Christian et al., 2020a) and the manuscript Christian et al. (2021) each address this failure and the failure to prevent other questionable research practices. All our data sources provide evidence of unsatisfactory and unacceptable workplace circumstances for too many ECRs; it appears there is more work to be done regarding questionable research practices. That 13% of ECRs feel unsafe at work is of great concern; it is important to find out why they feel unsafe, and who is making them feel this way. I wonder why 16% men feel unsafe, and who is frightening them. There is no acceptable reason to justify the circumstances behind comments such as the one below:

> passing out in the lab and other workspaces in the last 2 months due to health issues resulting from harassment and still being told I'm not working hard enough. (Survey respondent 589)

4.3.2.6.7 Perceived Lack of Alternate Careers

The perceived lack of suitable alternate careers contributes to the experience of ECRs and is a second area of concern. While their working environment is coloured by job insecurity, many feel they do not have the skills or qualifications for work elsewhere. This situation is discussed more fully in Chapter 5 (Section 5.2) and in Chapter 6 (Section 6.2.2) but is relevant here as it appears the workplace culture focusses only on the value of academic research and does not help the ECRs consider or prepare for "other" careers as viable alternatives. Although the ECRs are very likely to move away from academic research after only a few years as there will be no funding to support them, appropriate expectations are not

set, and the academic workplace does not provide advice. Having to leaving academic research is often regarded as having failed (Åkerlind, 2005; Payne, 2018).

At the same time, there is evidence that potential employers either under-estimate the value of a postdoctoral researcher or have the perceptions that they might have been inadequately prepared for their positions (Edwards et al., 2011; Edwards & Smith, 2008; Walton et al., 2018).

4.4 Exploration for Additional Factors Contributing to Job Satisfaction for ECRs in STEMM

In order to try to address the problems found for ECRs in STEMM, I was interested to identify any changes that could be readily introduced to the research workplace and allow ECRs to develop in a more fulfilling research environment. These changes could even lead to better science as suggested by Signoret et al. (2018) who felt the difficulties encountered by ECRs in Sweden could be due to high job demands and low job resources. Signoret et al. identified seven variables of substantial interest which emerged as statistically significant predictors of the perceived possibility to conduct best science - job clarity, university support, work time management, quality of life satisfaction, perceptions of career opportunity within academia as well as within the same university, and contract length.

I had thus far developed a long list of factors expected to influence job satisfaction for ECRs in STEMM, derived from both the literature and from my analysis of the on-line survey data. These are summarised in Table 18.

Table 18:

Factors Expected to Influence Job Satisfaction

External Factors/Working Conditions	
External Environment	**Institutional Choices**
Job security	Leadership and management
Number of post doc positions	Supervision
Contract stability (duration)	Workplace culture
	Availability of mentoring
	Beneficial review process
	Working conditions
	Workload
	Working hours
	Nature of job structure
	Professional development opportunities
	Flexibility
	Equitable hiring practices
	Support for career development
	Career planning
	Availability of research resources
	Need for relocation
	Salary
Internal Factors	
Personal feelings (Personal My Work)	**Impact of others**
Stress	Beneficial supervision and mentoring
Feeling valued	Attitude re age
Freedom to pursue research interests	Attitude re gender
Flexibility	Attitude re ethnicity
Inclusion and diversity	Questionable research practices
Feeling safe	Bullying and harassment
Confidence in prospects	Feeling unsafe
Reality vs expectation	Pleasure in teaching or supervising
Family responsibilities	
Work-life balance	
Excess working hours	
Quality of life	

It can be seen in Table 18 that these factors are grouped into “external factors”, i.e. outside influences and “internal factors” which are more personal to the individual. I recognise that in this Table there are similar concepts appearing in more than one position.

Long working hours, for example, might be expected by the institution; these in turn might take the form of excess working hours at home which have an impact on personal feelings.

As a next step I used structural equation modelling (SEM) to further investigate the relationship between the quantitative responses of my on-line survey participants in order to best represent the groups of factors relating job satisfaction in the academic STEMM workplace in Australia, and/or to ascertain which factors appeared to be most important or influential. This modelling will be discussed below.

4.4.1 Use of Structural Equation Modelling to Measure Job Satisfaction in Research – a Systematic Literature Review

In preparation for this part of the project I conducted a systematic review of the literature for articles published since (Johnsrud & Rosser, 2002), described in detail in Chapter 3 (Section 3.9.1.2.1). As previously mentioned, this systematic review revealed a gap in the literature for conceptual models of factors contributing to job satisfaction for people in the STEMM disciplines, or for those working in the research in universities or research institutes which could be applied to quantitative data. I wanted to introduce to my conceptual framework all factors which appear to be important to researchers in the STEM environment.

4.4.2 Modelling Job Satisfaction for ECRs in STEMM

I sought to extend the previous work by Rosser et al. (detail following) which modelled factors contributing to job satisfaction in academia. As described in Section 3.5 my conceptual framework was based on the framework for intention to leave created by Johnsrud & Rosser (2002) and further developed in later work on job satisfaction and intention to leave (Rosser, 2004), changes in job satisfaction over time (Rosser, 2005) and job satisfaction and productivity (Mamiseishvili & Rosser, 2011). I also took the framework for job satisfaction

developed by Basak & Govender (2015) for satisfaction of university academics into consideration in developing my initial framework. Basak and Govender's main factors for job satisfaction included the work itself, salary and compensation, job security, working conditions, promotional opportunities, supervision, administration and management, individual's personal characteristics, facilities, commitments and workloads. I was able to make some useful comparison with the work of Gonzalez et al. (2019) who explored supports and barriers to early-career academics. Although my on-line survey clearly indicates many respondents are dissatisfied with aspects of their worklife, the framing of the on-line survey questions did not permit me to use this model to measure dissatisfaction so I developed it as a single factor model of satisfaction. As reported in Chapter 3, my systematic review of the literature confirmed that there appears to be no research which describes conceptual models of factors contributing to job satisfaction for people employed in the scientific environment, or the research environment, in universities or research institutes and which could be applied to quantitative data.

Guided by factors identified by Rosser (2004) and Basak and Govender (2015) as contributing to job satisfaction, and included in my initial conceptual framework, we used SPSS AMOS v25 to explore responses to questions related to these factors to estimate the correlations for groups of factors with job satisfaction and thus optimise a model to predict job satisfaction. The method for the modelling process is described in Chapter 3 (Section 3.9.1.2.2).

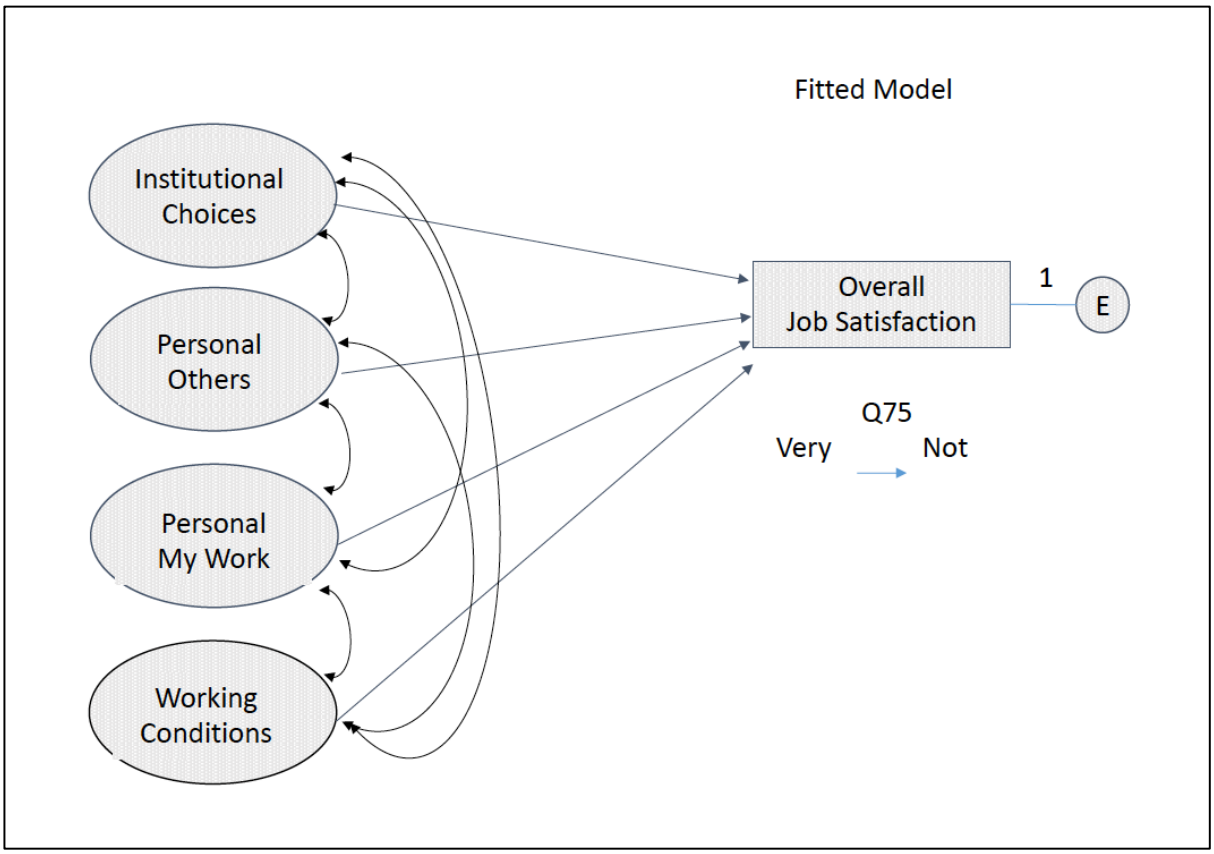
4.4.2.1 Results of SEM Modelling

Structural equation model modelling (SEM) using AMOS v.25 was used to quantify the strength of the pathways between the four latent variable constructs and job satisfaction (described in detail in Section 3.9.1.2 and shown in Figure 6), and hence prioritise their

impact on overall job satisfaction. SEM is an extension of generalized linear modelling (GLM) which allows multiple linear regression models to be fitted simultaneously to a conceptual graphical representation of the relationships between observed (manifest) and unobserved (latent) variables (Arbuckle, 1983).

Figure 25:

Revised Conceptual Model for Job Satisfaction



The data set used to construct the SEM included 891 cases. The resulting model, illustrated in Figure 25, achieved a stable minimum with both the chi square value and degrees of freedom being zero. Whilst no p-value could be calculated due to the degrees of freedom being zero because the number of distinct sample moments is identical to the number of fitted parameters estimated within the model, the chi square value of 0 indicates that the p-value is likely 1.00. A p-value greater than 0.05 indicates that the model fits the data. Other

descriptive fit measures describing this model indicate that even though the data set was likely of sufficient size for the number of parameters and pathways to be estimated (a rule of thumb of at least 15 cases per latent variable), due the incomplete nature of the data set requiring estimation of missing parameters by the maximum likelihood method, the results should be considered indicative in nature rather than predictive. The model returned an RMSEA of 0.220; a Tucker Lewis Index (TLI) was unable to be calculated but is likely to be high and close to 1.00. Values of RMSEA < 0.06 and a TLI > 0.95 indicate a well-fitting model.

To converge to a stable model given the degree of estimation of missing data, each of the predictive pathways from the four latent variables to job satisfaction was pre-set to a value of 1. Interpretation of the modelled parameters therefore explores the explanatory weighting of each shared pathway, using covariances for the pathways connecting each latent variable and multiple squared correlations for each of the factor groupings, rather than standardised regression estimates which are identical for each variable.

Table 19:

Covariance Estimates for each Predictor Pathway

Covariances	Estimate	S.E	C.R	P
Personal_MyWork <- -> Working_Conditions	.041	.033	1.227	.220
Personal_Others <- -> Working_Conditions	.045	.026	1.770	.077
Institutional_Choices <- -> Personal_Others	.238	.022	10.990	***
Personal_MyWork <- -> Institutional_Choices	.338	.029	11.847	***
Institutional_Choices <- -> Working_Conditions	.064	.031	2.048	.041
Personal_MyWork <- -> Personal_Others	.190	.021	8.837	***

Table 19 gives estimates for the covariances for each internal pathway between the latent variables included in the model as illustrated in Figure 25. Covariance is an estimate of

how much the two factors vary together as well as the direction of the variance (Arbuckle, 1983). A higher value indicates more tightly coupled connections. All the pathways in this model have positive covariances indicating they increase mutually. The dominant pathways here, in order of strength of covariance, are between Institutional Choices and Personal MyWork (0.338), Institutional Choices and Personal Others (0.238) and between Personal MyWork and Personal Other (0.190). The low covariance measures here for the other pathways indicate that they have little impact. It appears that the overall choices made by the institution that set cultural standards have the greatest interconnectivity, impacting both how others constrain and control an individual's working environment and in their self-perception of aspects of their work. There is also a not-unsurprising linkage between an individual's feelings about their work and the impact of others on them and that work. Interestingly, the contracted working conditions for an individual (hours worked, excess workload, fraction of employment and stability of contracts) is shown not to be influential.

Table 20:

Squared Multiple Correlations for Each Variable (R2 values)

Correlations	Estimate
Q075	1.116
PersonalMyWork	-.264
WorkingConditions	-.075
PersonalOther	-.811
Institutional	-.310

The squared multiple correlations given in Table 20 are R^2 values quantifying the explanatory power of the each of the latent variables within the model against job satisfaction. The estimate for Q75 "How would you rate your overall satisfaction with your current job?" is > 1 indicating that this model has sufficient power as an exploratory model of job satisfaction.

The closer the absolute values of these R^2 values are to 1, the greater explanatory power that factor grouping has on job satisfaction. Here we see that the impact of others on the working environment and culture of an individual is the strongly dominant explanatory variable for job satisfaction (Personal Other = -0.811). Institutional choices (-0.311) and Personal MyWork (-0.264) are weaker explanatory predictors of job satisfaction. Individual contractual and workload conditions (Working conditions = -0.075) have a negligible impact on job satisfaction. This supports the earlier finding that contractual working conditions do not contribute strongly to job satisfaction in this cohort.

Using SEM on the collected data we have identified and ranked the relevant factors that may impact on the job satisfactions of ECRs in the STEMM environment. In agreement with the earlier analysis provided in this chapter and in its included papers, it appears the immediate impact of others on the ECRs' working environment has the greatest influence on their job satisfaction. This latent variable construct includes measures of attitude towards age, gender and ethnicity, exposure to harassment and questionable research practices, supportive leadership and effective performance review.

It was also interesting to make a comparison with the work of Gonzalez et al. (2019) who has investigated job satisfaction in ECRs in USA. Although Gonzalez et al. employed a different method, social cognitive career theory (SCCT), after Lent et al. (1994), for which they conducted content analysis on interviews with 49 ECRs, their groupings of supports and barriers were similar to mine. Their "external barriers" (which included workload, collegial environment, lack of resources) were like those in "Institutional Choices"; their "internal barriers" (work-life balance, personal emotional state) were similar to "Personal MyWork"; "external supports" (university environment, supportive mentors, research collaborations) were similar to "Personal Others" and "internal supports" (internal personal states and

personal preferences) “working conditions”. Gonzalez et al. (2019) set aside “lack of funding” as an external constraint. In findings similar to mine, they found the impact of others on the ECRs’ working environment has the greatest influence on their job satisfaction as their most frequently cited supports were university environment, mentoring and research collaboration while the most frequently cited barriers included lack of current collegial support. Their findings were different in that lack of resources and faculty workload were also significant barriers.

Miller & Feldman (2015) examined dissatisfaction in ECRs, as opposed to satisfaction. Their analysis indicated several factors associated with a higher probability of ECR dissatisfaction: they found the research being conducted and its relationship to the individual’s interests and career goals, interaction with the supervisor, and demographic factors all influence the postdoc experience. They found dissatisfaction is less likely when the postdoc finds the current research project interesting, when the postdoc appointment is consistent with future career interests—especially continuing as an academic researcher—or was undertaken for skills development). Again, these findings are consistent with my findings.

There are possible limitations for this proposed model, as some factors might be symptoms, not causes, as was suggested by Miller and Feldman (2015) for elements of their model; they wondered, for example, whether reduced interaction between ECRs and their supervisors was a symptom of dissatisfaction or a cause. It is difficult to tell in some situations where the dissatisfaction originates.

It is possible the factors identified in this model are applicable not just for ECRs but for all who work in STEM research. It would be interesting to explore this in further research.

4.5 Factors Which Do Not Influence Job Satisfaction for This Cohort

Salary is the only factor reported in the literature as important for job satisfaction (Faupel-Badger et al., 2017; Judge et al., 2010) which appears to be largely a non-issue for these Australian ECRs. Only 4.9% respondents selected "better pay" as the answer to Q33 "If you could change one thing" and there were few comments to this effect. Consistent with views of (Manger & Eikeland, 1990), seeking opportunities for professional growth is far more important than income when academics change jobs and there are very few comments indicating salary is a problem. This is not surprising as Australian scientists are certainly well paid compared with those in many other countries (Zusi, 2016) and salaries, set by university enterprise agreements, are fairly uniform across the country. One respondent even suggested a reduction in salary:

> I would be happy to see our ECRs payed [sic] a lower salary (more in line with what is offered overseas) if it resulted in a greater number of positions for research. (Survey respondent 182)

4.6 Factors Which Influence ECRs to Stay in Research

Surprisingly, in the light of the many difficulties outlined above, many of these factors contribute more to a decline in job satisfaction rather than to no satisfaction at all. These ECRs generally report a relatively high level of satisfaction (though lower than the national average reported by Cassells (2017) and many go to great lengths to stay in their positions. As pointed out in Christian et al. (2021), the main reason for this appears to be that they very much enjoy their science, their actual work. In the free text answers to Q76 "It is recognised that there are some difficulties for ECRs in working in a research environment in STEMM disciplines. Why do you choose to stay in academia?", the words "love", "enjoy" and "passion" or "passionate" are each used many times. While it is acknowledged that this could

be seen to be, to an extent, a leading question, it is the second last question of the on-line survey and could not influence responses to any question other than Q77 “Is there anything you would like to add which has not been covered in this survey?”. As I was well aware of the troubles experienced by many ECRs in STEMM, I genuinely wanted to know the answer.

Figure 26:

Word Cloud for Q76 “Why do You Stay?”

(Reproduced in Christian et al. 2021)

The word clouds shown in Figure 26 – from on-line survey comments (reproduced in (Christian et al., 2021) - and Figure 27 from the focus group discussion each give a clear picture of what the ECRs love about their jobs. Figure 26, the word cloud from responses to Q76 “Why do you stay?” offers “love”, “like, “enjoy”, “interesting”, “people”, “rewarding”,

“opportunities” and “passionate”, all in the context of “research”, “academia”, “job” and “working”.

Table 21:

Instances of Words Suggesting Satisfaction or Dissatisfaction in Responses to Q76 Why do you stay?

Words Suggesting Satisfaction	# of Instances (word and derivatives)	Words Suggesting Dissatisfaction	# of Instances (word and derivatives)
Love	108	Secure	25
Like	54	Challenge	25
Enjoy	52	Leave	23
Interest	39	Impact	17
Opportunity	35	Stress	12
Good	33	Hard	12
Difference	30	Difficulty	12
Flexibility	29	Competition	12
Passion	27	Problems	11
Stay	23	Contract	10
Reward	21	Pressure	10

In the word count for both Q76 “Why do you stay?” and for responses to the same question from the focus group, the words which suggest satisfaction (in order of number of appearances) and their derivatives appear many more times than the words suggesting dissatisfaction, as can be seen in Table 21.

These responses to Q76 "Why do you stay?” provided further evidence of the conundrum described above for ECRs: the ECRs love many elements of their work while its benefits have to be viewed from within a very difficult environment. In Table 21 I aimed to draw out the words which suggested both the benefits of their research worklife and its disadvantages, one set often seen in the context of the other.

While “security” could indicate well-being, in the context of these answers most instances of use of “security” referred to the lack of security and there were also four instances of "insecurity". Similarly, "challenges” could suggest either the thrill of the chase

and its associated difficulties, (and in some instances this was so), however most uses of "challenges" and its derivatives described difficulties experienced by the ECRs.

Figure 27:

Word Cloud for Focus Group "Why do You Stay?"

The same question asked of the focus group participants elicited similar responses displayed in Figure 27 though with the exception of "like" and "love" there is a little less clarity of their views about the whole environment. Although there were only seven participants, "love" is used 7 times and "like" 42 times.

Further, although it does not show clearly in the word cloud, in responses to "Why do you choose to stay in academia?", ECRs report they enjoy their independence and freedom to follow their research questions, and the flexibility that the life of academic research provides.

Many mention their need to “make a difference” and some say they enjoy both teaching and learning. Although they might be very busy, it appears there are benefits to them in balancing work through the week, day and night, completing it either at the workplace and at home. Although it comes out in the modelling of on-line survey results (see Chapter 5) as a factor of importance with respect to job satisfaction and intention to leave, “feeling valued” is mentioned only twice in the answers to this question.

4.7 Conclusions about Principal Factors which Shape the Experience of ECRs in the Sciences

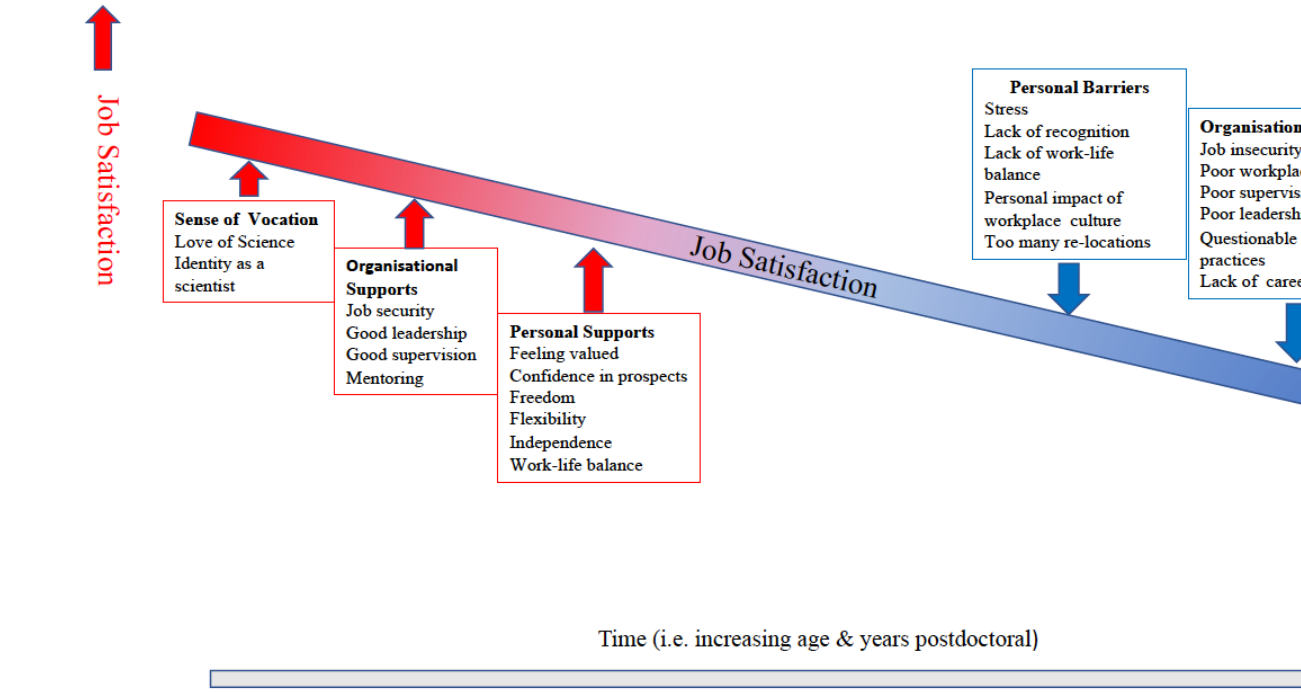
In summary, I have found that the job insecurity overwhelms all other factors pertaining to job satisfaction in in the academic research workplace. The short-term nature of jobs of many ECRs permits the institutions to minimise their investment in those ECRs and to overlook their duty of care while they use them as a resource to produce papers and attract funding to support the teams of their seniors afloat.

In this competitive environment, my respondents bemoan the apparent lack of attention to inappropriate behaviours such as bullying and harassment and questionable research practices. Supervision is regarded as being very poor and becomes worse as people gain seniority; mentoring is not made available as often as it should be. Training which could assist their careers either inside academia or in careers elsewhere is regarded as a poor investment in time and of little importance.

On the basis of the findings regarding job satisfaction from analysis of both qualitative and quantitative data discussed in this chapter I pose a revised conceptual framework for factors influencing job satisfaction for ECRs in STEM in Figure 28.

Figure 28:

Conceptual Framework for Job Satisfaction for ECRs in STEMM



As age increases and time passes, the influence of factors influencing job dissatisfaction increases.
Job satisfaction for ECRs is *not* influenced by gender, country of origin, family status, institution type, research outputs, salary, professio
support (outside core funding)

As illustrated in Figure 28, job satisfaction is contributed to by the sense of vocation, supported by positive benefits provided within the organisation which have a personal impact (described as “personal others” in the model) together with attributes of the work which have a personal impact (included in “personal my work” in the model). These are increasingly counterbalanced, with time, by personal and organisational barriers and overall job satisfaction decreases.

In Chapter 5 I will discuss the ramifications of the job insecurity and other characteristics of the STEMM environment for ECRs with respect to job satisfaction of ECRs and their motivations to leave or plan to leave the research workplace.

In Chapter 6 I will address the need for professional development and propose a new framework for job satisfaction and intention to leave for people working in the academic research environment as well as summarising the findings and providing recommendations to address some of the issues described in this chapter.

Chapter 4 References

Åkerlind, G. S. (2005). Postdoctoral researchers: Roles, functions and career prospects. Higher Education Research & Development, 24(1), 21–40. https://doi.org/10.1080/0729436052000318550

Arbuckle, J. R. (1983). IBM SPSS AMOS User Guide. IBM.

Austin, J. (2007). Lab-Management Training—As Bad as We Suspected. Science. http://blogs.sciencemag.org/sciencecareers/2007/11/labmanagement-t.html

Bartone, T., Kennedy, T., & McArdle, H. (2019). The AMA Gender Equity Summit Report. Australian Medical Association.

Basak, S. K., & Govender, D. (2015). Theoretical Framework Of The Factors Affecting University Academics Job Satisfaction. International Business & Economics Research Journal (IBER), 14(2). https://doi.org/10.19030/iber.v14i2.9167

Bell, S. (2009). Women in Science in Australia: Maximising productivity, diversity and innovation. Federation of Australian Scientific and Technological Societies (FASTS).

Bogle, D. (2018, June 27). How could universities and funders improve the situation for postdoctoral scientists? NatureJobs. http://blogs.nature.com/naturejobs/2018/06/27/how-could-universities-and-funders-improve-the-situation-for-postdoctoral-scientists/

Browning, L., Thompson, K., & Dawson, D. (2016). It takes a village to raise an ECR: Organisational strategies for building successful academic research careers. International Journal for Researcher Development, 7(2). www.emeraldinsight.com/2048-8696.htm

Butler, D. (2008). Translational research: Crossing the valley of death. Nature, 453(7197), 840–842. https://doi.org/10.1038/453840a

Capewell, S., & ECR Subcommittee. (2017). Academic careers: What do early career researchers think? Journal of Epidemiology Community Health, 71(2), 207–208. https://doi.org/10.1136/jech-2016-207438

Cassells, R. (2017). happy workers: How satisfied are Australians at work? Curtin Business School, Curtin University. https://bcec.edu.au/publications/happy-workers-how-satisfied-are-australians-at-work/

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. (2020a, July 29). What are questionable research practices as reported by ECRs in STEMM in Australia? Research Ethics Monthly. https://ahrecs.com/uncategorized/what-are-questionable-research-practices-as-reported-by-ecrs-in-stemm-in-australia/

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. R. (2020b). Survey of Australian STEMM Early Career Researchers: Job insecurity and questionable research practices are major structural concerns. BioRxiv. https://doi.org/10.1101/2020.02.19.955328

Christian K, Johnstone C, Larkins J, Wright W, Doran MR. A survey of early-career researchers in Australia. Rodgers P, Deathridge J, Lijek RS, Rolf H, Hussain T, editors. eLife. 2021 Jan 11;10:e60613

Department of Industry, Science, Energy and Resources. (2020). STEM Equity Monitor—Summary Report 2020. Australian Government. industry.gov.au/stemequitymonitor

Dolgin, E. (2017). The young and the restless. Nature, 551(7678), S15–S18. https://doi.org/10.1038/551S15a

Dorsey, D., & Mueller-Hanson, R. (2017). Performance Management that Makes a Difference: An Evidence-based Approach (Science-to-Practice Series). Society for Human Resource Management.

Dunstone, M., & Williamson, B. (2016). Gender Equity: Current Issues, Best Practice and New Ideas.

[Editor, Nature]. (2013). Women's Work. Nature, 495.

[Editor, Nature]. (2014). Harsh Reality. Nature, 513.

Edwards, D., Bexley, E., & Richardson, S. (2011). Regenerating the Academic Workforce. The careers, intentions and motivations of higher degree research students in Australia. Findings of the National Research Student Survey. Australian Council for Educational Research. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0009/1490940/RAW_Combined.pdf

Edwards, D., & Smith, T. F. (2008). Supply, demand and approaches to employment by people with postgraduate research qualifications in science and mathematics: Literature Review and Data Analysis. Australian Council for Educational Research.

Eley, D. S., Jensen, C., Thomas, R., & Benham, H. (2017). What will it take? Pathways, time and funding: Australian medical students' perspective on clinician-scientist training. BMC Medical Education, 17(1), 242. https://doi.org/10.1186/s12909-017-1081-2

Faupel-Badger, J. M., Nelson, D. E., & Izmirlian, G. (2017). Career Satisfaction and Perceived Salary Competitiveness among Individuals Who Completed Postdoctoral Research Training in Cancer Prevention. PLOS ONE, 12(1), e0169859. https://doi.org/10.1371/journal.pone.0169859

Gascoigne, T. (2012). Career support for researchers: Understanding needs and developing a best practice approach. Australian Council of Learned Academies Commissioned by the Department of Industry, Innovation, Science, Research and Tertiary Education.

Gonzalez, L. M., Wester, K. L., & Borders, L. D. (2019). Supports and barriers to new faculty researcher development. Studies in Graduate and Postdoctoral Education. https://doi.org/10.1108/SGPE-D-18-00020

Hofmann, B., Bredahl Jensen, L., Eriksen, M. B., Helgesson, G., Juth, N., & Holm, S. (2020). Research Integrity Among PhD Students at the Faculty of Medicine: A Comparison of Three Scandinavian Universities. Journal of Empirical Research on Human Research Ethics, 1556264620929230. https://doi.org/10.1177/1556264620929230

Horbach, S. P. J. M., Breit, E., Halffman, W., & Mamelund, S.-E. (2020). On the Willingness to Report and the Consequences of Reporting Research Misconduct: The Role of Power Relations. Science and Engineering Ethics. https://doi.org/10.1007/s11948-020-00202-8

Huang, J., Gates, A. J., Sinatra, R., & Barabási, A.-L. (2020). Historical comparison of gender inequality in scientific careers across countries and disciplines. Proceedings of the National Academy of Sciences, 117(9), 4609–4616. https://doi.org/10.1073/pnas.1914221117

ilovebraaains. (2012). The Business of Running a Lab. https://everydaybiochemistry.wordpress.com/2012/04/02/the-business-of-running-a-lab/

John, L. K., Loewenstein, G., & Prelec, D. (2012). Measuring the Prevalence of Questionable Research Practices With Incentives for Truth Telling: Psychological Science. https://doi.org/10.1177/0956797611430953

Johnsrud, L. K., & Rosser, V. J. (2002). Faculty members' morale and their intentions to leave: A multilevel explanation. The Journal of Higher Education, 71(1), 34–59.

Johnston, E. (2020). The impact of COVID-19 on women in the STEM workforce [Rapid Research Report]. Australian Academy of Science. https://www.science.org.au/covid19/women-stem-workforce

Judge, T. A., Piccolo, R. F., Podsakoff, N. P., Shaw, J. C., & Rich, B. L. (2010). The relationship between pay and job satisfaction: A meta-analysis of the literature.

Journal of Vocational Behavior, 77(2), 157–167. https://doi.org/10.1016/j.jvb.2010.04.002

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance. Journal of Vocational Behavior, 45(1), 79–122. https://doi.org/10.1006/jvbe.1994.1027

Mackay, F. (2020, March 3). Why women need a boost in research. The Australian. https://www.theaustralian.com.au/higher-education/uni-of-melbournes-fabienne-mackay-explains-why-women-need-a-boost-in-research/news-story/362d52b4dbafc119bf8a7fd5f59a11fc

Mamiseishvili, K., & Rosser, V. J. (2011). Examining the Relationship between Faculty Productivity and Job Satisfaction. Journal of the Professoriate, 5(2), 100–132.

Manger, T., & Eikeland, O.-J. (1990). Factors Predicting Staff's Intentions to Leave the University. Higher Education, 19(3), 281–291. JSTOR.

Miller, J. M., & Feldman, M. P. (2015). Isolated in the Lab: Examining Dissatisfaction with Postdoctoral Appointments. The Journal of Higher Education, 86(5), 697–724. https://doi.org/10.1353/jhe.2015.0029

Misra, J., Lundquist, J. H., & Templer, A. (2012). Gender, Work Time, and Care Responsibilities Among Faculty. Sociological Forum, 27(2), 300–323. https://doi.org/10.1111/j.1573-7861.2012.01319.x

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. Proceedings of the National Academy of Sciences, 109(41), 16474–16479. https://doi.org/10.1073/pnas.1211286109

Moss-Racusin, C. A., Sanzari, C., Caluori, N., & Rabasco, H. (2018). Gender Bias Produces Gender Gaps in STEM Engagement. Sex Roles, 79(11), 651–670. https://doi.org/10.1007/s11199-018-0902-z

Myers, K. R., Tham, W. Y., Yin, Y., Cohodes, N., Thursby, J. G., Thursby, M. C., Schiffer, P., Walsh, J. T., Lakhani, K. R., & Wang, D. (2020). Unequal effects of the COVID-19 pandemic on scientists. Nature Human Behaviour, 1–4. https://doi.org/10.1038/s41562-020-0921-y

Noble, K., Owens, J., André, F., Bakhoum, S. F., Loi, S., Reinhardt, H. C., Tuveson, D., & Swanton, C. (2020). Securing the future of the clinician-scientist. Nature Cancer, 1(2), 139–141. https://doi.org/10.1038/s43018-019-0005-y

Pain, E. (2014). An emerging global picture of early-career scientists. Science Careers. http://www.sciencemag.org/careers/2014/01/emerging-global-picture-early-careerscientists

Payne, D. (2018). Career changing encounters. NatureJobs. http://blogs.nature.com/naturejobs/2018/01/10/cristina-lo-celso-career-changing-encounters/

Payne, D. (2019). The professional advisers who can help you to move from academia to industry. Nature, 567, 135. https://doi.org/10.1038/d41586-019-00747-0

Rosser, V. J. (2004). Faculty Members' Intentions to Leave: A National Study on Their Worklife and Satisfaction. Research in Higher Education, 45(3), 285–309. https://doi.org/10.1023/B:RIHE.0000019591.74425.f1

Rosser, V. J. (2005). Measuring The Change in Faculty Perceptions Over Time: An Examination of Their Worklife and Satisfaction. Research in Higher Education, 46(1), 81–107. https://doi.org/10.1007/s11162-004-6290-y

Sattari, N., & Sandefur, R. L. (2019). Gender in academic STEM: A focus on men faculty. Gender, Work & Organization, 26(2), 158–179. https://doi.org/10.1111/gwao.12249

Science and Technology Australia. (2019). STA Submission: Sexual harassment in the workplace. https://scienceandtechnologyaustralia.org.au/wp-content/uploads/2019/02/STA-Submission-Sexual-harassment-in-the-workplace-.pdf

Shine, J., Bradlow, H., O'Reilly, S., & Godfrey, B. (2019). Women in STEM Decadal Plan (Australian Academy of Science) (p. 62). Australian Academy of Science. https://www.science.org.au/support/analysis/decadal-plans-science/women-in-stem-decadal-plan

Signoret, C., Ng, E., Da Silva Heil, S., Tack, A., & Voss, U. (2018). Well-Being of Early-Career Researchers: Insights from a Swedish Survey. Higher Education Policy. https://www.researchgate.net/publication/323073459_Well-Being_of_Early-Career_Researchers_Insights_from_a_Swedish_Survey

Smith, D. K. (2020). The race to the bottom and the route to the top. Nature Chemistry, 12, 101–103.

Van Noorden, R. (2018). Some hard numbers on science's leadership problems. Nature, 557, 294–296.

Walton, C. (2016). Best and Brightest—Advancing Medical Research—2016 Medical Research Institute Sector Survey Report. Professional Scientists Australia. http://www.professionalsaustralia.org.au/mri/advocacy/campaigns/medical-researchers/

Walton, C., Walker, K., & Porter, R. (2018). Professional Scientists Employment and Remuneration Report. Professionals Australia. http://www.professionalsaustralia.org.au/financial-edge/salary-survey-reports/scientists5/

Wellcome Trust. (2020). What researchers think about the culture they work in. Wellcome Trust. https://wellcome.org/reports/what-researchers-think-about-research-culture

Williams, W. M., & Ceci, S. J. (2015). National hiring experiments reveal 2:1 faculty preference for women on STEM tenure track. Proceedings of the National Academy of Sciences, 112(17), 5360–5365. https://doi.org/10.1073/pnas.1418878112

Wood, D., Griffiths, K., & Emslie. (2020). Cheaper childcare: A practical plan to boost female workforce participation. Grattan Institute. https://grattan.edu.au/report/cheaper-childcare/

Zusi, K. (2016). Life Sciences Salary Satisfaction Survey. The Scientist Magazine. https://www.the-scientist.com/?articles.view/articleNo/47311/title/2016-Life-Sciences-Salary-Survey/

Chapter 5|

What are the Motivations for ECRs Leaving Academic Research in the Sciences?

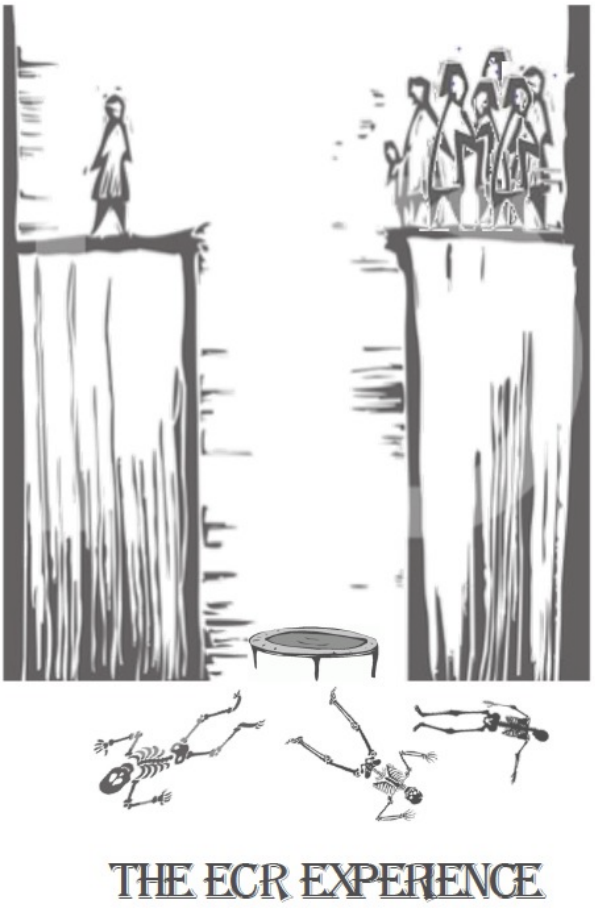


Image included with permission of Prof Don Newgreen

5.1 Introduction

In Chapter 5, I address the research question "What are the motivations for ECRs leaving academic research in the sciences?". There has been limited investigation of the individual experiences of ECRs in STEM and the factors that influence their satisfaction or dissatisfaction with their appointments (Miller & Feldman, 2015), however addressing these concerns is important as they have implications for the future of the careers of these individuals as well as for science at large.

Within this Introduction to Chapter 5, I briefly discuss known factors from the literature, previously described in Chapter 2, which contribute to intention to leave, then move on in Section 5.2 to investigate those factors as they have emerged from my research project as a whole, viewing those factors with respect to ECRs in STEMM.

Given there is a difficulty in retention of women in STEMM in Australia (Shine et al., 2019), in Section 5.3 I particularly address intention to leave for women. This section incorporates findings from in-depth interviews of eight women who, at the time of interview, had recently left their academic STEMM workplaces; supporting qualitative data from the open-ended questions in the on-line survey is also incorporated in this analysis. Towards the end of this section, I investigate the impact of gender and family circumstances, for both men and women, on their intention to leave.

Finally, in Section 5.4 I report the outcomes from modelling quantitative data from the on-line survey for factors associated with intention to leave, particularly employing data from questions relating to those factors I expected to impact on intention to leave for ECRs working in STEMM disciplines.

5.1.1: Factors Contributing to Intention to Leave

In this section I address factors identified in the literature as affecting intention to leave. This will be followed by an exploration of intention to leave versus actually leaving. I discuss findings from this research project with respect to those factors within Section 5.2.

Identification of the various factors which contribute to intention to leave will help provide answers to the question about the motivations to leave. As discussed in Chapter 2, while intention to leave has been shown to be linked to job satisfaction, it has also been shown to be linked to organisational commitment (Bashir & Gani, 2019), and the literature shows there are yet more factors which contribute to intention to stay or leave. These include workplace culture and collegiality (Grinstein & Treister, 2018; Manger & Eikeland, 1990), level of interaction with supervisors (Miller & Feldman, 2015), availability of mentoring (Gascoigne, 2012), freedom to follow a research question (Miller & Feldman, 2015) and feeling valued (Ryan et al., 2012). McAlpine & Emmioğlu (2015) note little is known of how ECRs perceive and navigate career choices over time and find that ECRs are influenced in their decision-making processes by both the scarcity of jobs and by personal factors. While salary has been shown to be a factor contributing to both job satisfaction (Basak & Govender, 2015; Bentley et al., 2013) and intention to leave (Johnsrud & Rosser, 2002) for academics in general, it is interesting that salary appears not to be an issue for most ECRs in this study. Rather, my findings support the work of Manger & Eikeland (1990), who found that seeking opportunities for professional growth is far more important than income when academics decide to change jobs.

Dissatisfaction with the postdoctoral experience contributes to the decisions of many ECRs to change career, and thus they do not realise the full returns either to their personal or to societal investments (Miller & Feldman, 2015). Grinstein & Treister (2018) investigated

the consequences of dissatisfaction by measuring participants' responses to a question which asked whether the ECRs would recommend the postdoc track to others and found that only 28.4% "agreed" or "definitely agreed" that they would recommend the postdoc path to others.

It has been shown that while many ECRs leave academic science, sometimes science ECRs leave science altogether as demonstrated, for example, in a survey of doctorate recipients conducted by the US National Science Foundation which showed 18% of employed people with science and engineering PhDs were no longer working in science fields in 2017 (Foley et al., 2019).

5.1.2 Intention to Leave and Leaving

There are two schools of thought about the relationship between intention to leave and actually leaving. Manger & Eikeland (1990) support the work of Finkelstein (1984) claiming studies of "job changing" among university staff do not show a strong relation between intention to leave and actual leaving. They found that only a small proportion of those staff who indicate that they are considering leaving the university actually leaves, even if non-academic opportunities are readily available. Others feel differently and show that intention to leave is a strong factor in actual leaving the academic workplace (Bludorn, 1982; Gardner, 2012; Lee & Mowday, 1987). It is no surprise that there are differing views as the decision to actually leave is complex (Smart, 1990) and is dependent on the context in which it occurs (McCain et al., 1983). Part of the difference in view could relate to the authors' focus on gender; Gardner (2012) concludes women are more likely to act on the decision to leave than are men because they are more influenced by the consequences of family responsibilities.

5.2 Findings from this Project with Respect to Intention to Leave

All elements of this mixed methods project have contributed to my understanding of the motivations for ECRs in STEMM fields to leave academic research. For investigation of motivations for intention to leave, I particularly use the data collected from the on-line survey, both quantitative and qualitative, triangulated with data from the eight in-depth interviews.

Although the interviews were with women who had already left academic research, it seems many of my on-line survey respondents had also reached their decision to leave at the time of the survey. This quote from Survey Respondent 234 provides evidence that he or she is planning to leave, and will be following many other young scientists in Australia from their cohort:

> Something needs to change with funding for research in Australia. People wonder why younger people move away or move out of science... of the 20 people I studied with and graduated with at university, only 2 of us are still working in science, and I am studying another degree to open up my employment opportunities. (Survey Respondent 234)

In this study, as described in Chapter 4, I have found there is significant job dissatisfaction for ECRs in STEMM. Here, in Chapter 5, I will show that my study participants, who are strongly impacted by job insecurity and resultant stress, have a very high intention to leave. Seventy-eight percent of the on-line survey respondents have indicated they have considered a major position or career change in the past five years Christian et al. (2021) and of these, 61% have done something about it. In this section of Chapter 5 I will explore the reasons the study participants have given for their intention to leave, look at intention to leave with respect to the ECRs' early expectations and compare intention to leave for this cohort with research about academics from all disciplines. I will also investigate the decisions of

ECRs regarding where to go next in their careers. As the differences if any, for intention to leave for women compared with men is a topic which creates considerable interest, examination of the differences between genders, is within its own section, Section 5.3.

5.2.1 Intention to Leave vs Factors Known or Suspected to Contribute to the Decision

I assessed intention to leave against factors known or suspected to contribute to leaving academic research in STEMM and, from the data collected in all study methods, identified that the factors of importance to Australian ECRs in STEMM, with respect to intention to leave, are: job security, job satisfaction, supervision and mentoring, freedom to follow a research question, feeling valued, workplace-related stress and personal needs. Of these, job security is the most important factor. These findings are consistent with all but one of the factors identified by others which have been specified earlier in this chapter. Organisational commitment (Ashford et al., 1989; Podsakoff et al., 2000) is the outlier which was never mentioned by my study participants; salary, which is of importance in other countries (Basak & Govender, 2015; Zusi, 2016), was mentioned occasionally but does not appear to be an issue of consequence.

In Section 5.2.2 I discuss findings from the on-line survey with respect to those principal factors identified in the literature as contributing to intention to leave; the important factors which emerge for this cohort are job insecurity and job satisfaction. Following this section, I compare my findings with those of others who investigated job satisfaction and intention to leave in Australian academia and for ECRs in STEMM in the USA. Last, I investigate whether expectations at the start of their postdoctoral career has an influence on intention to leave before moving on to decisions about a career change.

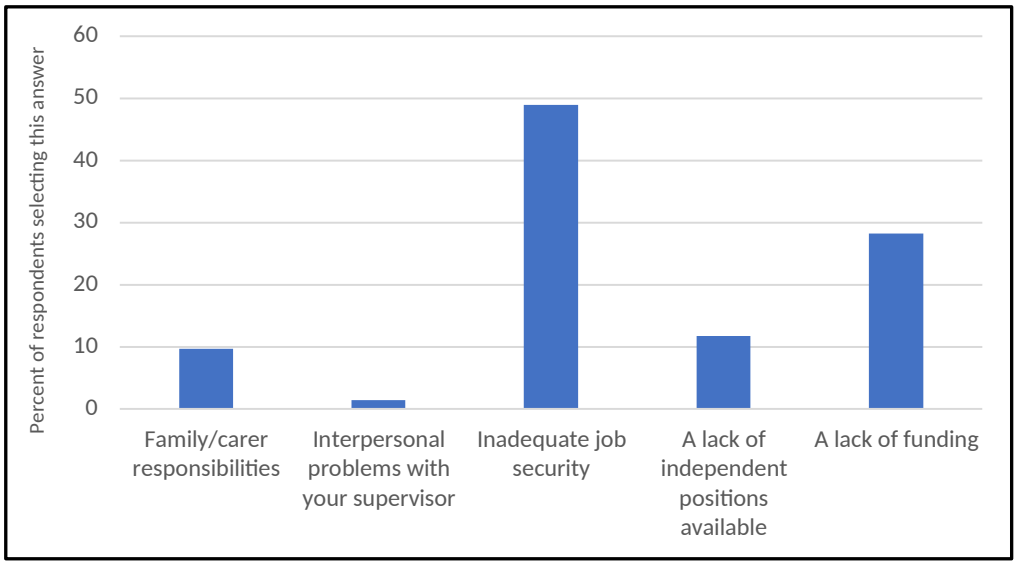
5.2.2 Findings from On-line Survey Data

I begin with findings from the analysis of quantitative data from the on-line survey. Just as Manger & Eikeland (1990) found intention to leave the university can be influenced by a range of factors, I, too, found intention to leave was influenced by some job-related factors and some more personal factors. First, I review in detail the principal factors which contribute to intention to leave, namely job insecurity and job satisfaction.

5.2.2.1 Job Insecurity

Figure 29:

The Main Reasons Given by Respondents for Why They Might Leave Research



Q67 "What would be the main reason to leave research?" had six possible responses from which respondents could select one. Figure 29 shows responses to five of those options; the option "Other" (not included in this graph because it is treated by LimeSurvey as a separate question), permitted an open-text response which is shown below in Table 25. The data shows job insecurity is the ECRs' biggest issue (49%). The next most important issues are closely related: lack of funding (28%) and lack of independent positions (12%), creating a

combined total for job insecurity and lack of funding (variations of the same problem) of 89%.

5.2.2.2 Job Satisfaction

As there is a known link between job satisfaction and intention to leave, I assessed intention to leave against job satisfaction by performing a cross tabulation of Q75 "How would you rate your overall satisfaction" vs "intentleave", a binary variable created from Q61 "Within the last five years have you considered any major career or position changes?".

Figure 30:

A Comparison of Levels of Job Satisfaction with Stated Intention to Leave their Current Job

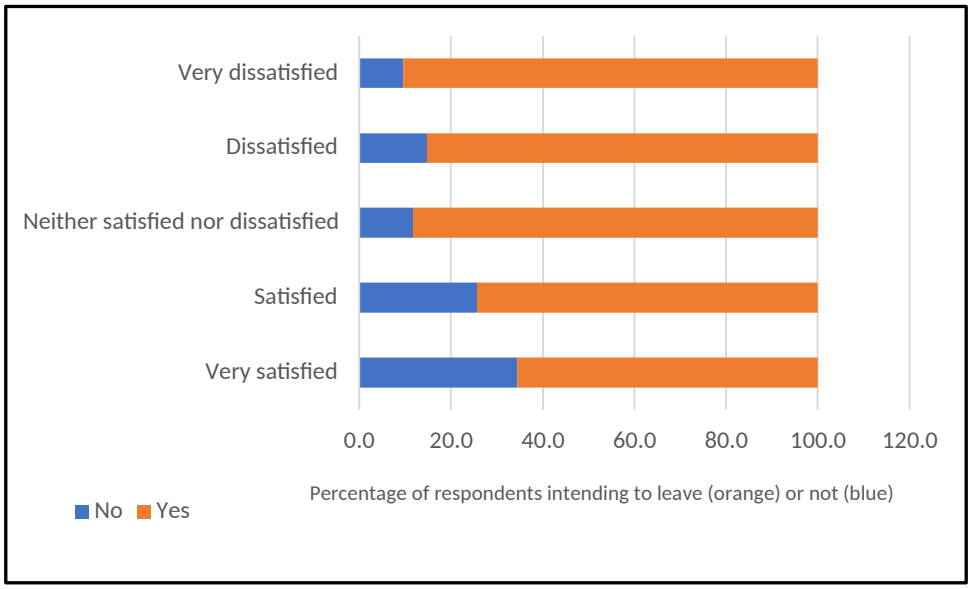


Figure 30 shows that dissatisfied people (dissatisfied and very dissatisfied) had much higher intention to leave than satisfied people (satisfied and very satisfied); the difference in responses between "yes" and "no" groups is significant (Chi-square = 16.996, df = 4, p= 0.002). While there is no way to measure how many people have actually left their position,

61.8% of respondents reported that they had taken some concrete action towards a major change of career or position. In the face of statistics which suggest the possibility of such considerable change one must hope that the view of Manger & Eikeland (1990) that intention to leave is not a strong indicator of actual leaving is correct or many research groups will be without a substantial part of their workforce.

Here we face a conundrum perhaps not explored by Manger & Eikeland: that of clear evidence of high job satisfaction for ECRs in STEM with regard to their actual research at the same time as clear evidence of dissatisfaction with the workplace environment and its range of stressors. Answers to Q76 "Why do you choose to stay in academia?", some of which are included in Box 1 within Christian et al. (2021) (see Section 4.2.2) show that ECRs principally stay because they "love science" or "love research", which brings them both their vocation and identity. In keeping with the studies mentioned in Chapter 4, it is clear that many ECRs in my study relish their freedom to follow their research questions, their independence and their flexibility. Many also love their teaching and their supervision of students in spite of the workload it brings. At the same time, they report extraordinary dissatisfaction with important elements of the workplace such as supervision received (or not), questionable research practices and safety at work, as reported in Christian et al. (2021). As a consequence, we find their satisfaction with their work is high while their dissatisfaction with their workplace or workplace culture is reflected by poor work-life balance and often extremely stressful working conditions.

5.2.2.3 Comparison with Other Work on Job Satisfaction and Intention to Leave

I sought to extend the work of others (Bell & Yates, 2015; Bentley et al., 2013; Coates et al., 2008; Coates & Goedegebuure, 2007, 2012; Grinstein & Treister, 2018) on intention to leave via responses to the range of questions "This is a Poor Time for a Young Person to

Begin an Academic Career", "If I had to Do it Again I would Not Become an Academic" and "My Job is a Source of Considerable Strain" which reflect the early expectations of ECRs about the job, and a fourth question about overall job satisfaction "How would you rate your overall satisfaction with your current job?". Responses to these four questions in the on-line survey are discussed below, followed by comparisons with other work which has used these questions.

Figure 31:

Level of Agreement with "This is a Poor Time to Begin an Academic Career"

Compared with Stated Intention to Leave

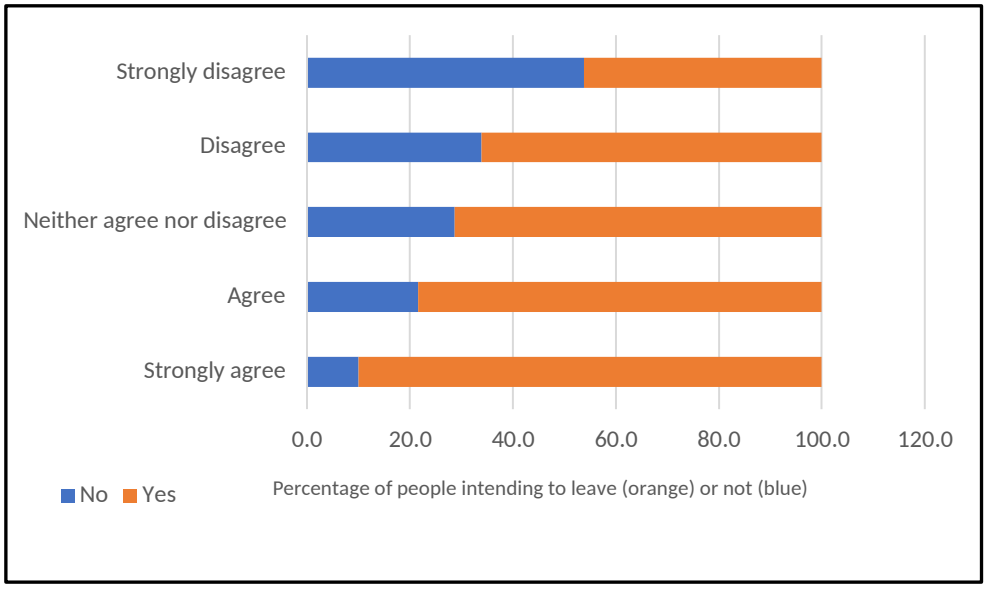
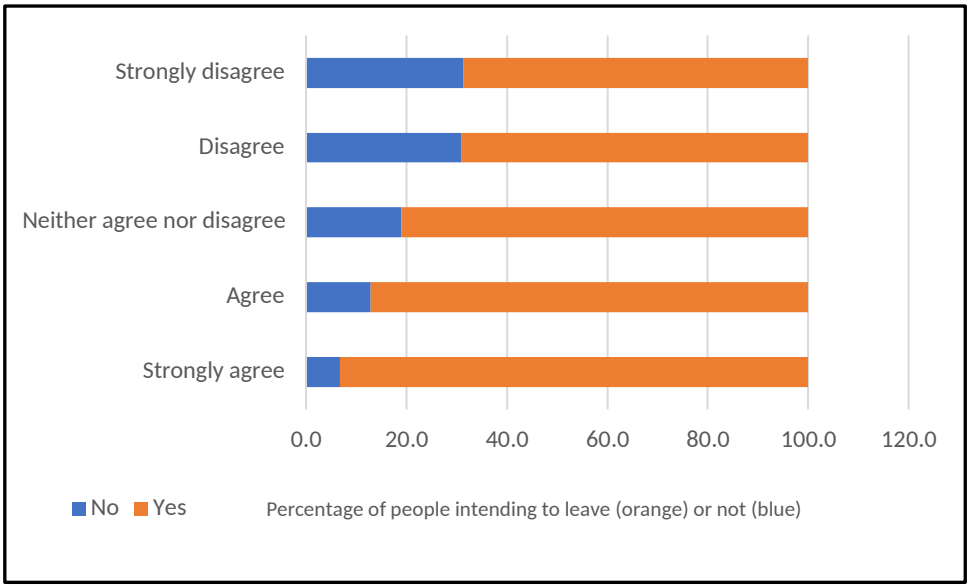


Figure 31 shows responses to Q74-1, "This is a Poor Time for a Young Person to Begin an Academic Career" in a cross-tabulation against intention to leave. As could be expected, those who agree with this statement are most likely to be intending to leave.

Figure 32:

Level of Agreement with "If I had to Do it Again I would Not Become an Academic" Compared with Stated Intention to Leave



The sentiment for “This is a poor time for a young person to begin an academic career” is consistent with responses shown in Figure 32. Here those who are least likely to leave are most likely to disagree with “If I had to Do it Again I Would Not Become an Academic”.

Figure 33:

Agreement with "My Job is a Source of Considerable Strain" Compared with Stated Intention to Leave

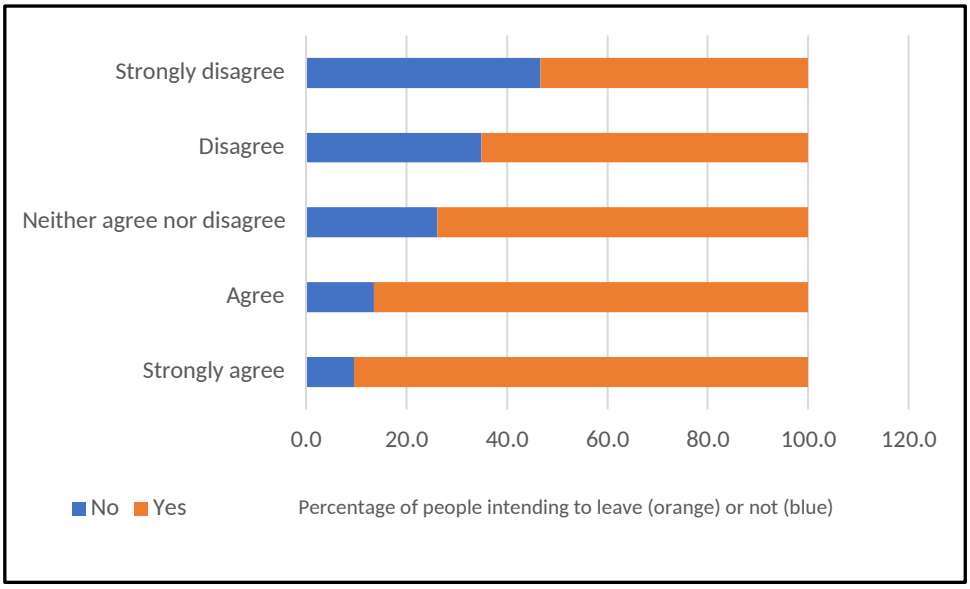


Figure 33 shows the third part of this question measured against intention to leave. Again, those who are most likely to leave are most likely to agree with “My Job is a Source of Considerable Strain”.

Although there is consistency in responses from people with apparent unhappiness and stated consideration of intention to leave, it is interesting that there are mixed messages here from the responses. While the majority (65%) consider this is not an appropriate time for others to begin an academic career, and more than half (52%) find their job a source of personal strain, only 32% agree that they would not do it again. This points again to the love of science counteracting the strains of the job.

I next sought to compare my findings for these four questions with those of others who had used the same or similar survey questions.

Table 22:

Responses to Grinstein and Treister Question Compared with Responses to Current Study Questions

Study	Questions	% Agree
Grinstein and Treister	Agreed would recommend career path to others	28.8%
Current study	Agreed this is a poor time to start an academic career	64.6%
Current study	Agreed if they had it do it again they would become an academic*	45.2%
Current study	Disagreed my job is a source of personal strain	24.7%

*disagreed they would not become an academic

As stated above, I examined whether ECRs would be likely to recommend this STEMM career path to others in responses to a set of questions measuring job satisfaction. While not identical, these questions provided the possibility of a comparing answers to the question posed by Grinstein & Treister (2018) which enquired whether ECRs would recommend the postdoc track to others. Their respondents have given very different responses to those from my study, shown in Table 22. Where Grinstein and Treister (2018) found 28.4% of their respondents "agreed" or "definitely agreed" to recommend the postdoc path to others, I found 64.6% of my on-line survey respondents disagreed “this is a good time to start an academic career” (given they either "agreed" or "strongly agreed" that “this is a poor time to begin an academic career”). Only 15% did not agree it was a poor time for others to begin and 20% neither agreed nor disagreed. Further, 45.2% "disagreed" or "strongly disagreed" “if they had it do it again they would not become an academic”, while 22.4% had no opinion either way. The question asking for agreement to “my job is a source of personal strain” more closely aligns with the Grinstein and Treister (2018) response.

These four questions ("This is a poor time for any young person to begin an academic career in my field"; "If I had it to do over again, I would not become an academic"; "My job is a source of considerable personal strain"; and "How would you rate your overall satisfaction with your current job?" have been used previously in many studies as they are from the Changing Academic Profession (CAP) survey, run in 25 countries. The work likely to be of most interest for Australians is that of Coates et al. in their work on the Australian academic profession (reported in Bentley et al., 2013; Coates et al., 2007, 2008, 2009, 2010, 2012, 2015). While they investigate academia in Australia across all levels and faculties, and acknowledging their data is now at least 13 years old, it is worth noting there are some significant differences in responses to these same questions when applied to ECRs in the sciences as demonstrated in Table 23.

Following the example of Bentley et al. (2013), I calculated job satisfaction as a factor-based score: the job satisfaction index is an unweighted sum of four Likert scale items measuring satisfaction with different aspects of academic work. Three questions required responses from "strongly agree" (1) to "strongly disagree" (5) for the following questions: "This is a poor time for any young person to begin an academic career in my field.", "If I had it to do over again, I would not become an academic", "My job is a source of considerable personal strain". The fourth question asked for a rating from 1 to 5 for: "How would you rate your overall satisfaction with your current job?".

Table 23:

Comparison of Results from Bentley et al. (2013) and the Current Study

Question	CAP Study reported in Bentley et al. (2013) Academics from all disciplines (2007 data) n=1097			Current study ECRs in STEM (2019 data) n=469		
	Mean	**SD**	**% reporting satisfaction (score more than 3)**	**Mean**	**SD**	**% reporting satisfaction (score more than 3)**
Job satisfaction index	3.11	0.95	51	2.86	0.89	39%
"this is a poor time to begin an academic career" [a]	2.77	1.39	36	2.22	1.11	15
"If I had to do it over again I would not become an academic" [a]	3.60	1.30	58	3.14	1.25	45
"my job is a source of personal strain" [a]	2.64	1.26	28	2.59	1.18	25
Overall satisfaction with current job Q75R[b]	3.42	1.09	55 (score above 3)	3.48	1.08	62 (score above 3)
Report have taken direct action towards leaving in the past 5 years		52.5% (C & G 2009)				61.8%

[a] runs 1 strongly agree to 5 strongly disagree
[b] runs 1 very dissatisfied to 5 very satisfied

As shown in Table 23, on a scale of one to five, Bentley et al. (2013) show Australian academics reported a mean job satisfaction index of 3.11; my study respondents were less satisfied overall with a mean job satisfaction index of 2.86. Their earlier study reported 51%

of participants had a job satisfaction index score of over 3 (i.e. satisfied or very satisfied); my study had only 39% with a job satisfaction index over 3. Although 62% of participants reported overall job satisfaction in response to "How would you rate your overall satisfaction with your current job?", the answers to "My job is a source of considerable personal strain", "This is a poor time for any young person to begin an academic career in my field. and "If I had it to do over again, I would not become an academic", all of which have lower scores, bring the job satisfaction index down for the ECRs in the current study.

As in the Coates study, most negativity came from the questions about personal strain of an academic career and poor conditions for young academics. Only 25% of my respondents disagreed with "my job is a source of personal strain" compared with 28% reported by Bentley et al. (2013) (2007 data) and 30% reported by another Australian study conducted in 2010 (Bexley et al., 2011).

Fifteen percent of ECRs disagreed with "this is a poor time to begin a career as an academic", far fewer than reported by Bentley et al. (2013) (36%) or in an earlier Australian study by McInnes (1999) (1999 data) who reported disagreement from 23% (data not shown). These results indicate this cohort of ECRs in STEM are more discouraged by the academic life ahead for them than other academics, or perhaps are more discouraged than academics from earlier times. Either way, this is poor reflection on a current career in STEM research. Even though Australia has been shown as the country where academics are more likely to have considered a major job change than any other in the CAP study (Coates et al., 2015), the results show the likelihood is even greater for ECRs in STEM disciplines.

Reporting data collected in the 2007 CAP Study, Bentley et al. (2013) showed academics from middle ranks (assistant lecturers, lecturers and senior lecturers) indicated lower satisfaction than those in the upper ranks (associate and full professors). They cross-

validated this with interviews carried out across Australia with postgraduate research students and ECRs in science and mathematics (Edwards & Smith, 2008). Here they found perceptions of an increasingly unmanageable workload for academics at all levels within universities. Students who had begun research degrees with the intention of becoming academics displayed little interest in pursuing the same work that they had witnessed their supervisors burdened with as they were nearing the end of their research training and were instead examining options in the private sector or government. Edwards and Smith concluded the increasing frequency in which academics were finding themselves stuck on the 'post doc treadmill' (Edwards & Smith, 2008, p.13) suggested that the postdoctoral pathway was no longer acting as the stepping stone into tenured academic positions that it once was. Instead, it was likely that many young researchers would be discouraged from following an academic career. My on-line survey respondents clearly demonstrate they have drawn the same conclusions, as has been shown in Tables 22 and 23.

Table 24:

Responses to Commonly Used Job Satisfaction Questions from Five Australian Studies Compared with Current Study

Study	Coates (academics all stages)	Bexley (ECRs) 2010	Prof Sci (MRIs all stages) 2015	Bell and Yates 2015 (STEM all stages)	NTEU 2017 (academics all stages)	Current study (ECRs) 2019
Questions				% agree		
I have good job security		26		38	36	17
My job is a source of considerable personal stress	28	38		43		52
This is not a good time for any young person to aspire to an academic career in my discipline	36	39		46		65
I have freedom to pursue my own research interests		58		47		55
Satisfaction with my job*	55	62	67	71	78	62
I feel my work is valued				74	46	61

* For "Satisfaction with my job" questions, Bell & Bexley question: "Generally speaking I am satisfied with my job"
Other studies: "How would you rate your overall satisfaction with your current job"
(Table is reproduced in Christian et al. 2021)

Table 24 above describes responses to the commonly used job satisfaction questions discussed above in five Australian studies (Bell & Yates, 2015; Bexley et al., 2011; Coates et al., 2009; National Tertiary Education Union, 2017; Walton, 2016); each of these studies used one or more of the "job satisfaction" questions in surveys of Australian academic workforces.

It can be seen respondents from the current study are much more concerned about job security than respondents in any of the other studies. They also have higher level of personal stress (52%) than those in all the other studies (28%-43%) and agree most strongly (65%) “this is not a good time for any young person to aspire to an academic career”. Their reported job satisfaction is low (62%). The combination of answers to these questions for current ECRs relative to those for the other studies indicates a situation about which there should be grave concern.

5.2.2.4 Other Factors Contributing to Intention to Leave

Returning to Q67 “What would be the main reason to leave research?” (discussed in 5.2.2.1) “family responsibilities” at 10% is a long way behind the answers relating to job insecurity. Last is interpersonal problems with your supervisor (1%) selected by only six people. The remaining possibility from Q67, open-text responses within “Other” are shown in Table 25 and discussed below.

Table 25:

Detailed Open-Text Answers for the Main Reason to Leave Research within Response "Other" for Q67

Category for Reasons to Leave	Exact Comment
Job insecurity and lack of funding	All of the above
	A lack of funding - to me - encompasses inadequate job security and lack of independent positions
	No jobs
	Inadequate job security, Disability
	Job security is based on churning out a large quantity of publications, regardless of quality.
Workplace culture	Utter despair/heartbreak at watching my current institution fall to pieces around me culture with academics in the HE sector and the governments push for the corporatisation of the HE sector
	A culture of big egos limited funding and a protectionist environment has over decades created an environment that is not conducive to a posit
	Disonest [sic] system of recognition and reward
	no or little impact in real world, low job security
	Bad workplace culture
	Publish or perish culture
Lack of research support/support for research/Lack of time for research	Admin load, University making research too hard paperwork wise
	Teaching commitments taking time away from research
	Not able to build up a group due to limitations imposed by the university (e.g. specific graduate student admission criteria).
	Lack of time to conduct research in my workplace
	No balance between research and teaching
Interpersonal problems	interpersonal problems with other senior personnel
	Harassment
	Poor management
Workload /lack of work life balance or stress	Workload

Other (did not fit one of the categories in this Table)	The pressure to preform [sic] and lack of work life balance... The pressure of continual high performance and attracting funding would likely be too much and I'd opt for something easier and less stressful Not satisfying due to work load and limitations in creativity Stress, uncertainty in many aspects of an academic role Burnt out Excessive workload Lack of work life balance Work life balance Prefer teaching Retirement (three times) Self-development Passion and enjoyment of job {perhaps means lack of enjoyment?] A great position in a different field Have other interests in life This job is often very challenging and yet also boring. I do not gain a deep level of satisfaction from my daily activities.

Table 25 shows the 38 detailed responses for those who had selected "Other" for Q67 "What would be the main reason to leave research?" grouped by theme; together they portray a most unsatisfactory workplace environment. While it could be expected that the principal reason behind intention to leave would be job insecurity, there are other factors to consider, and these are often associated with job insecurity. The stressful environment which comes as consequence of the job insecurity and the associated constant pressure to publish and attract funds are certainly other factors contributing to job dissatisfaction. While some of these answers are actually aspects of job insecurity and lack of funding, the remainder reflect poor workplace culture, workload and work-life balance, lack of support for research and insufficient time for research.

Moving to the analysis of other qualitative data collected in the on-line survey, the open text responses to Q61 "Within the last five years have you considered any major career or position changes?", Q73 "How does your job as an early-career researcher meet your original expectations?", Q75 "How would you rate your overall satisfaction with your current job?", Q76 "Why do you choose to stay in academia?" provide clear insights into intention to leave for many respondents. I explored all responses coded in NVivo to "intention to leave" as described in Chapter 3. These are presented in Appendix F.

Figure 34:

Word Cloud Drawn from Responses Coded to Intention to Leave

The themes which emerge from within intention to leave, demonstrated in the word cloud in Figure 34, include the need or wish to leave because of job insecurity, concern about funding or obtaining a position or workplace culture. Workplace stress and harassment from supervisors are other themes which do not show in the word cloud. There is clear uncertainty

about where to go next, perhaps because there is nowhere to go, or because the options are unpalatable or due to lack of awareness of other employment options. There is also resounding concern here and elsewhere about wasting the efforts made by both the ECRs and their families to secure the PhD or current position.

This response from an on-line survey respondent encompasses most of the issues:

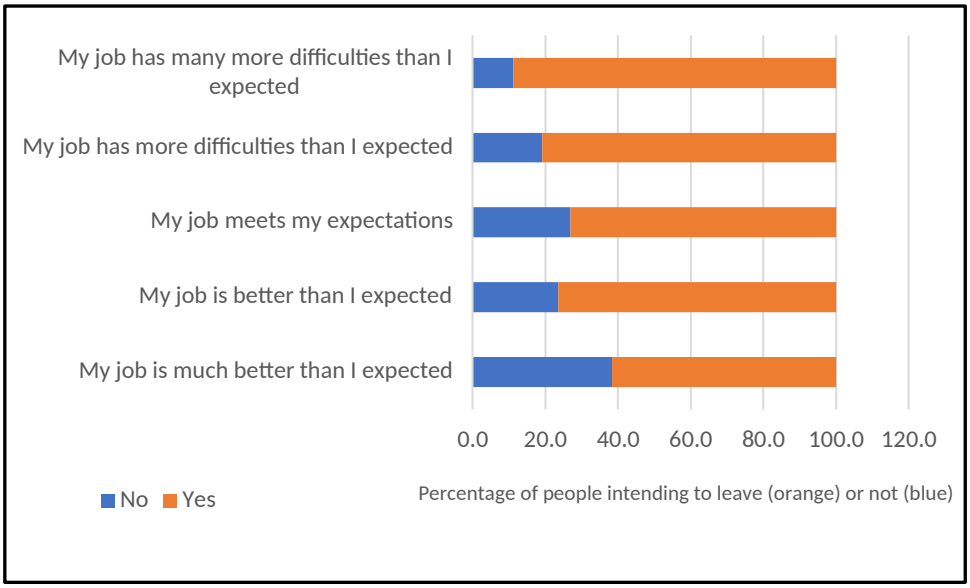
> The personal toll it takes to have an academic position is immense. The job insecurity, being unable to plan for anything beyond 1-maybe 2 years is debilitating. Constantly responding to this opportunity, and that opportunity, doing good clever work and being available at all times is tough beyond measure. Not knowing if all this personal sacrifice and tough hard work are even going to be worth it is downright demoralizing. It might all work out, and it might not - but when do you pull the pin?? (Survey Respondent 194)

5.2.2.5 Early Expectations

Having looked at the range of other factors contributing to intention to leave, I moved on to explore intention to leave with regard to the respondents' early expectations.

Figure 35:

Views about the Job Compared with ECRs' Early Expectations Compared with Stated Intention to Leave their Current Job



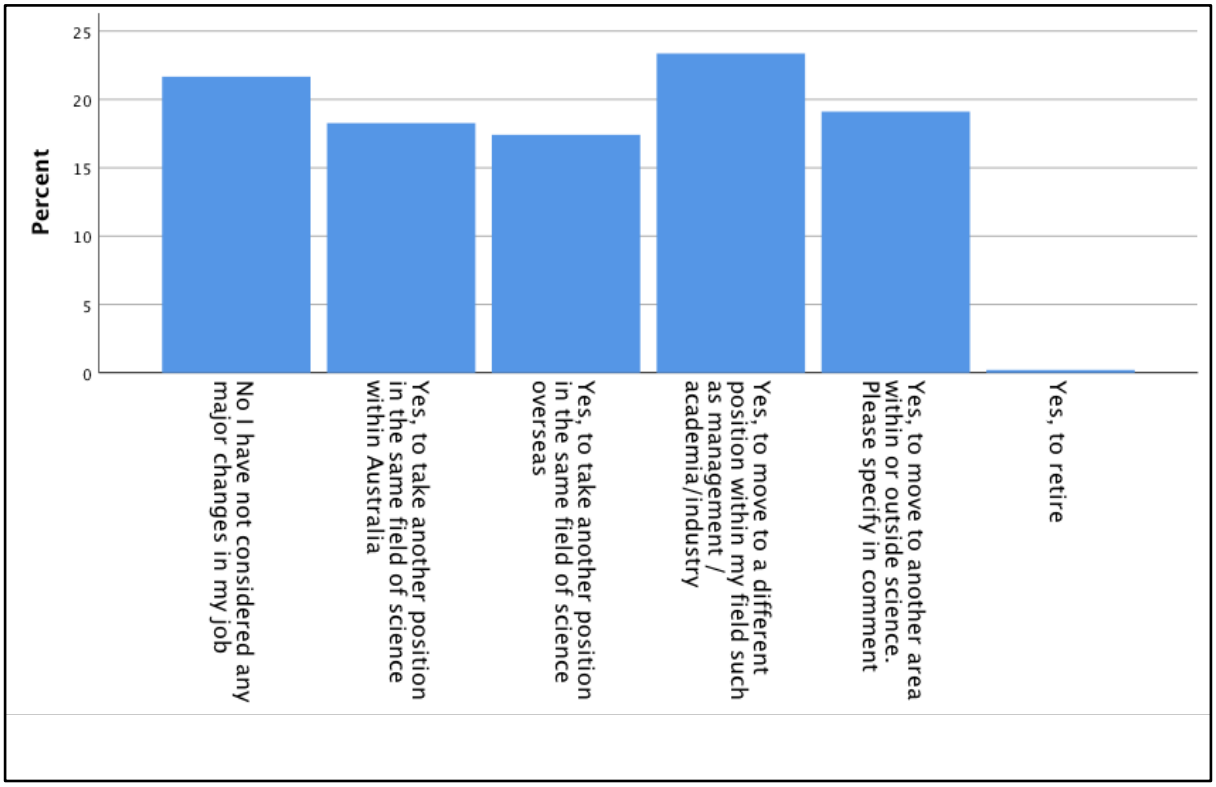
A crosstabulation of "Intentleave" against Q73 "How does your job as an early-career scientist meet your original expectations?" illustrated in Figure 35 suggests that those whose job has met or exceeded their expectations are more likely to plan to stay, while for those who find their job has more difficulties than expected there is a higher intention to leave. The difference, however, is not statistically significant (Chi-square = 9.428, df = 4, p= 0.051).

5.2.2.6 Considering a Career Change

When considering intention to leave Coates et al. (2009) reported that "Australia had the highest rate of academics considering a change, while academics in UK were more likely to take concrete action towards change"(Coates et al., 2009, p18). One must question why more has not been done to rectify this situation. I discuss the ECRs' consideration of career change in the following section.

Figure 36:

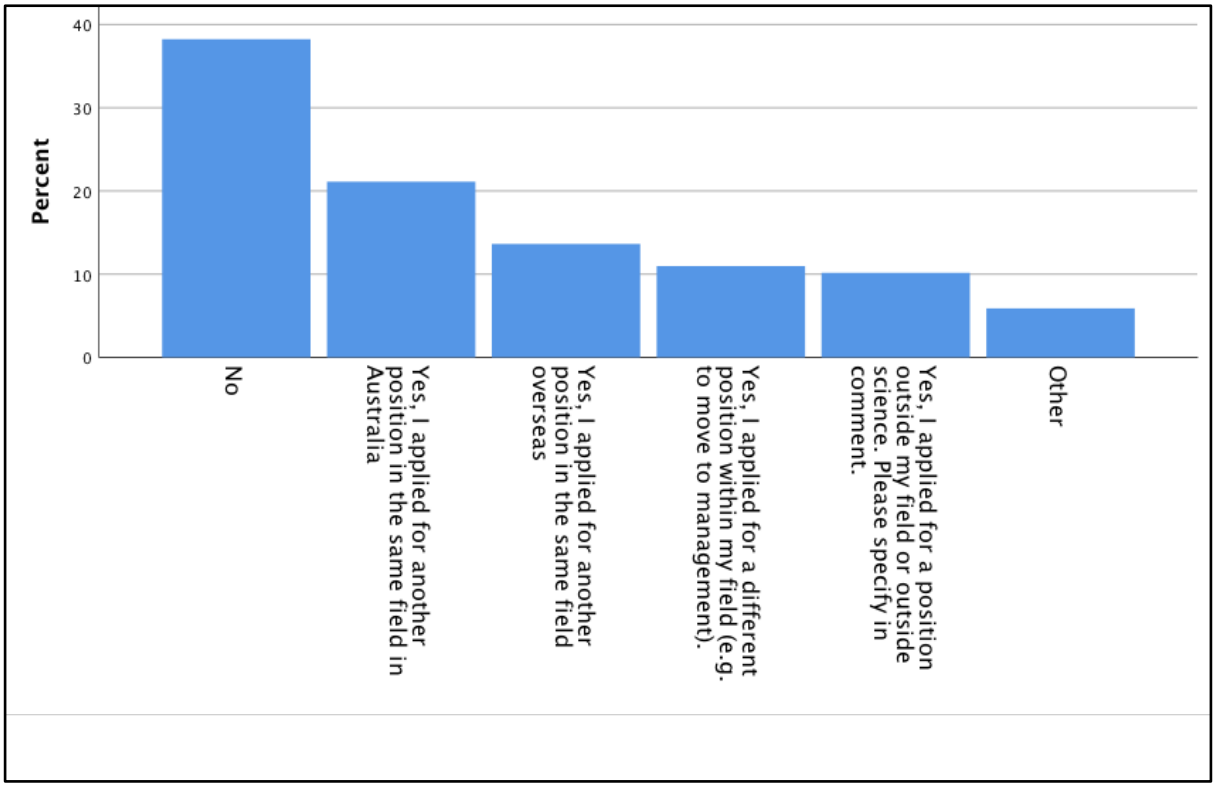
Responses to Q61 "Within the Last Five Years Have You Considered Any Major Career or Position Changes?"



As illustrated in Figure 36 above, almost 80% of my respondents reported that they had considered a major job or career change in the past five years. Answers were almost evenly balanced against the four "yes" categories; the fifth "yes" category with the answer "Yes, to retire" had only one response (0.2%) and is thus of minimal consequence.

Figure 37:

Responses to Q62 "Did You Take Any Concrete Action to Make Such Changes?"



When asked whether they had taken any action, 62% of respondents reported yes, as illustrated in Figure 37. While 21% indicated they had applied for another job in Australia, 14% had applied for jobs in similar fields overseas and a further 20% had applied for jobs either a different type of position in their field (such as a transfer to management) or outside science.

Open-text answers from the 92 respondents who selected "Other" for Q62 "Did You Take Any Concrete Action to Make Such Changes?" were many and varied; they were too diverse to readily present a useful pattern. Table 26 shows the broad categories into which they fell. The comments are shown in full, grouped by these broad themes, in Appendix H.

Table 26:

Broad Themes of Open-text Responses from Those Who Selected "Other"

Broad Theme
Not considering a change
Another academic position in academia, same field
Academic position overseas
Non research in academia / different position within my field
Change or potential change within science
Completely different field
Industry
Consideration given to change but decided to stay in academic research
Consideration given to new jobs but unsuccessful /Don't know what to do
Not specified or hard to tell

While some of the responses to Q62 could well have fitted into the specific options (no; yes to same field in Australia; yes to same field overseas; yes to a different field; yes to a field outside science) the open-text responses provide evidence of both people desperately trying to find a job, anywhere or others stressed by uncertainty about what to do next, where to go and even how to try. Some people have moved or are preparing to move to different fields within science, either in academia, industry or government. Those contemplating moving out of science altogether have considered an array of careers from starting a fashion label, yoga teaching to becoming a death duala. Uncertainty about the future is the overriding feeling which arises from these comments.

It is worthwhile comparing data collected in this study for the question "Within the last five years have you considered any major career or position changes?" with responses of ECRs to the same question for Bell & Yates (2015) (note in the Bell and Yates study ECRs self-identified they belonged in this category) and Bexley et al. (2011).

Table 27:

Comparison of Commonly Used Questions About Decisions to Make a Career Change

Possible Responses	Bexley	Bell and Yates **	Current Study
No I have not considered any major changes in my job	32.7%	20.0%	21.7%
Total "yes" answers	67.3%	78.9%	78.3%

* Bexley
**Bell and Yates ECR responses, n=317. Not all are in postdoctoral positions

Table 27 shows a comparison between three studies of responses to a question about decisions to make a career change. In the Bexley et al. (2011) study the answers were slightly different as they applied to academic positions in general rather than to STEM position. The responses for Bell & Yates (2015) are very similar to those for the current study, indicating the overall situation identified by Bexley et al. (2011) (from data collected in 2007) has shown no sign of improvement and the vast majority of academics are still considering leaving their field.

5.2.2.7 What or Where to Change to?

A question which relates to considering a career change is, of course, what or where to change to. Many ECRs have no idea what other career will suit them and there is little preparation provided by the institutions for alternate careers. This will be discussed in more detail in Chapter 6, but these comments from the on-line survey provide background:

> I have no idea where to find a job in a non-academic setting (it's very hard to have a conversation about this with uni colleagues, and even if you find someone who you feel comfortable with in bringing this up, they often don't know what to recommend because they have only ever worked in academia themselves).

> So lack of knowledge about alternatives has kept me trapped here. Plus I am so busy with work, that investing time to learn about other jobs is hard to prioritise. (Survey Respondent 384)

> There seems to be a real lack of consideration shown by research institutions to adequately prepare ECRs for a life outside of academia. We are told what we need to do in order to succeed in Academia, but meeting these expectations does not lead to any better job security or prospects going forward. As a result, we are not exposed to enough alternative career options or training opportunities to transition out of academia, which the majority of ECRs will likely have to do at some stage as there are not enough jobs for the number of PhD graduates that are pushed through by universities. (Survey Respondent 431)

Preparation for alternate careers is also discussed within the next section.

5.3 Intention to Leave for Women

There is an additional set of issues for women when considering whether to stay in or leave their position. Women within STEMM organisations in Australia report sexism, gender bias and lack of support have held back their careers (Walton, 2017) and sexual harassment also impacts women at a higher rate than men (Shine et al., 2019); these issues have all been reported by our study participants. In addition, the ECR years are typically at the time of childbearing, and the postdoc period has been identified as a point where many women exit or reduce their commitment to the scientific workforce (Martinez et al., 2007). Childbearing and child rearing is a contributor to work-related stress for parents of young families, particularly women, as many ECRs feel they "can't afford to get off the treadmill" (Bentley et al., 2013; Bexley et al., 2011) so they make the choice to leave altogether. The culture which promotes, or even expects, the ECRs to relocate to another lab, interstate or overseas, to enhance their

experience brings some benefits (Cantwell, 2011; Laudel & Bielick, 2019) but also creates further stress; this is particularly pertinent if the relocating ECR has a partner and young family. This practice is perhaps left over from a time when it was less likely both partners would work or the time when it was important to move to a large facility with special facilities not available elsewhere. The disruption to a family which needs to focus on the needs of two careers and/or the other needs of family members is a matter for serious consideration for the ECRs (Ackers, 2008; Laudel & Bielick, 2019; ResearchGate, 2020).

I examined all the issues mentioned above for the women who took part in this project. In the following sections I will report on the experiences of eight women who had recently left academic research and who took part in semi-structured in-depth interviews. I also report on findings from the on-line survey, extending the discussion into matters which impact parents of young families as opposed to only women.

In summary, I confirm the difficulties of combining a career in STEMM research with raising a family, while felt by both men and women, are likely to have more of an impact for intention to leave on women.

It is interesting to note the results of my on-line survey do not generally reflect more problems for women compared with men for those actually in the academic workforce as has been explained in Chapter 4 (Section 4.3.1.1) Here I showed that job satisfaction for men and women was the same across many measures. The exceptions were satisfaction with “attitude of people of my gender” and the reported extent of harassment based on power position. I have found that gender inequity was a problem for only some women (and a problem for some men). Harassment, including sexual harassment, which are reported in the literature to impact women more than men, while certainly affecting the job satisfaction of some of these ECRs, may not necessarily have affected their intention to leave.

I first report on findings from the interviews.

5.3.1 Findings from Interviews of Eight Women who had Recently Left the Academic Environment

In the following pages I will discuss the findings from the semi-structured in-depth interviews of eight women who had recently left the academic workplace for other employment. Unlike previous research about the experiences of senior women researchers (Gardner, 2012) or researchers across all academic disciplines (Browning et al., 2016, 2017), this research is significant as it focuses on women ECRs in STEMM, and has examined the difficulties faced by ECR women in the academic STEMM environment from the perspective of the women. These interviews led me to insights into the reasoning behind the decisions of these women to leave academia and thus add pertinent answers to the research question "what are the motivations for ECRs leaving the sciences?".

The interviews showed the women left a challenging and stressful workplace in which they had a clear need for greater job security and a better pathway for flexible working for those with care-giver responsibilities. Although their individual decisions to leave were difficult, the interviews showed the women who have moved to new employment have found fulfilling alternate careers, while retaining their satisfaction with their identity as scientists. They also provide further evidence of the situation described in Chapter 4, and supported by Wellcome Trust (2020), where we find researchers who are often very dissatisfied with their workplaces conditions are reluctant to take steps to leave as they almost always love their science, their actual work and do not want to go.

The findings from the interviews are presented in three parts, based on the recurring interview themes. First, I will describe the challenges these women faced in academia, including the influence of poor leadership on workplace culture. This will be followed by

examination of the reasonings behind the decisions to leave and explanations of planning for the alternate career, which are coloured by the importance of their identity as a scientist. Finally, I will explore the consequences of the decision to leave.

5.3.1.1 Challenges these Women Faced in Academia

The women shared their stories about their difficulties in academia, which were often the consequences of poor leadership. Providing support for the findings from both the on-line survey and focus group discussion, the eight interviews showed that while all the women had enjoyed their work, they had encountered many problems in the workplaces they had left behind. Again, as discussed in Chapter 4 and above in this chapter, job insecurity was their dominant concern. These women each chose to leave research to provide themselves with the job security they wanted and a defined career path. The quote below from Pixie is typical of the experiences of ECRs in STEMM:

> ...to me job security was a big issue. I wanted to find a job that I'd be able to stay in so I could have a family and get a mortgage from the bank and all that kind of stuff and academia was just really a difficult path from that perspective. So I felt like there was really a choice that had to be made - I've got another friend that was in another lab in a similar area — I think she's lived in three or four different cities in the last five years. So she's constantly moving, constantly moving onto the next post-doc.

Many of these women remarked on the lack of support from their supervisors. As reported in Chapter 4, this issue was reflected in the on-line survey, where 61% of respondents reported they had been impacted by poor supervision. They also commented that institutions provided them with insufficient support; there was little help offered with seeking

funding or with professional development. Laura commented that administrative staff, who tend to have more job security than research staff, did not necessarily provide ECRs with the support they needed.

It is not only ECRs who are under stress in academic STEMM research; their supervisors also feel the continual pressure to secure funding and to publish and this influences the workplace culture and impacts their leadership. Some supervisors feel they must drive their staff relentlessly (Powell, 2016). Sarah's lab provided an example of a poor workplace which was overseen by a highly successful researcher who was tough with his staff, and who was considered to be inequitable in some of his practices. Sarah said: "I think [lab head] was just there to just say, 'More results, more results, more results'. That was all he did."

The women reported significant inappropriate behaviour which they had observed or experienced at work, such as this reflected on by Daisy: "I think science is on the cusp of its own #Metoo movement actually. I think there should be a lot of male [Principal Investigators] out there feeling very uncomfortable".

As for the on-line survey respondents, all the women interviewed, other than Pixie, reported they had observed or been the victim of inappropriate behaviour in their previous workplaces. They reported bullying is common. Several of the women felt that the workplace pressure was responsible for the inappropriate behaviour at all levels, and that it was overlooked by or even participated in at senior levels.

Rosie told of an unhealthy environment:

> a system that's sort of set up to have people be super high achieving to be really competitive and it doesn't help foster a collegiate atmosphere or supportive working environment amongst peers and I've experienced that. Cutting everyone else down to get ahead.

When she was asked whether the senior staff were aware of or worried about this poor behaviour, Rosie replied: "Yes, I'm sure people knew about it. No **probably didn't care and certainly wouldn't do anything about it**." [sic] (emphasis added).

The women reported that ECRs, perhaps particularly women, are pushed very hard. Daisy said she had been worried about the well-being of women in her institution; especially those from culturally different backgrounds. She said the ECRs are often required to be at work for long hours and during weekends, apparently to assist the careers of their supervisors:

> they're very subservient women and they are made to work weekends, nights and nothing is ever good enough. And I've had multiple people … come to me in tears asking me for advice and the only advice I've ever been able to give them is to go.

All the women interviewed said they had encountered sexism, gender bias and lack of support in the academic STEMM workplace. The women often mentioned gender inequity as a characteristic of their work environment, however apart from Cecile and Rosie the women did not say it impacted them personally.

> Rosie: "there are a lot of other, more subtle things that happen that would be related to me being a young woman in a field that treats young women not very well. I guess - I don't know. Like not sexual harassment as such but just being treated in a different way and bullied in terms of hours that were expected to be worked and that sort of stuff."

Daisy said she felt just being a woman was holding her back in her career, even when she was recognised as a respected researcher:

> I wasn't going to all the big meetings and telling people how it was. I never felt that I had the licence to stand up and say, 'Actually I do know what I'm talking about and you're wrong'.

When explaining the difficulties some women experience in being assertive, Cecile said "I was constantly told I wasn't tough enough. 'Oh you're smart but you're not tough enough. You've got to toughen up. You've got to be like a man'."

Daisy set up a gender equity committee in her institution, but she did not feel she could take its unpleasant conclusions forward in the male-dominated workplace, instead allocating this task to a man.

All the women mentioned that flexible working and the ability to accommodate the needs of the family are important to women in the STEMM workforce. Those of my interviewees who had family responsibilities said they had chosen to change direction to accommodate the needs of their families; none of them mentioned that this was because looking after children was "women's work". The fact that family care could also have been provided by their partners was never raised.

Daisy was also affected by another type of gender inequity common to many women ECRs in STEMM: the need to continue to manage her lab during her maternity leave.

> I did get some more funding so the lab could continue. So I felt the pressure to go back [from maternity leave] – well it's not like I even really left. So because the lab was young and it needed me, I sort of still had to be in contact there on a daily basis and be writing and to be helping and thinking and driving everything. Because being a young person setting up something new that is yours, you can't delegate.

Last, with respect to gender inequity, which might to an extent be addressed with increased diversity in the workforce, it was interesting that a need for diversity in the workforce was never discussed in the interviews. Moving to sexual harassment, known to be a significant issue within STEM institutions in Australia and reported to impact women at a much higher rate than men (Shine et al., 2019); both Cecile and Rosie said they had been subjected to sexual harassment.

It is very easy for STEMM researchers at all levels to be caught in "an endless whirl of grants and papers" (McDonnell, 2019) and this whirl has clearly had an impact on these women. Whatever the reason for the pressure, for them the STEMM workplace had become an uncertain, unsupportive environment with a culture which became unacceptable to them. While the challenges in this work environment were not given as the reason any of these women chose to leave academia, they contributed to their decision to leave. I will discuss that critical decision below.

5.3.1.2 Taking the Decision to Leave

I also learnt, in the interviews, about the processes which led to the decisions to move elsewhere. The interviews showed their decision to leave resulted from the women's recognition that achieving success was not worth the struggle in the overly competitive, hostile environment where to remain would compromise their other priorities and sometimes their values. All eight women said they had chosen their careers because they loved science and wanted "to make a difference". Unfortunately, they did not find these needs were being met in academic research.

> Rosie: when I talk about falling out of love with research and all of that stuff that we just talked about with the harassment, bullying and harassment, that

> certainly has coloured my perspective and sped up my falling out of love with it as a career.

The women had both similar and different reasons to leave the academic STEMM environment although, as mentioned above, the ultimate decision to leave was to find job security, work-life balance, and to escape from the stressful environment. For those with, or planning for, families they wanted to be able to work in a more family-friendly environment.

The interviews showed the women had each arrived at their decisions to leave research after long and careful planning. All but Cecile decided to leave without the assistance of a career advisor; there was also no mention of discussions with their supervisors. Although they had planned their departure over a long period, they did not necessarily find it an easy decision to make because being a scientist was so integral to their identity:

> Daisy: I don't know how to do anything else. I won't survive. This defines me. What I do defines me — that was a really hard, dark period of time - and then I sort of had this initial sense of relief and then it sort of hit me. It was like – it was like grief.

Some of the women strongly felt that leaving was a waste of the hard work it had taken to reach their current positions and that abandoning this career would disappoint others. Tania: "The guilt I felt that I had failed and all of that investment and all of that faith in me I had squandered – it was awful. It was terrible!".

Cecile chose to move to industry because she did not know where she could otherwise go without doing more study. She was not confident she had the skills to leave academia, reflecting views from the on-line survey which show the ECRs were worried about being either under-skilled or over-qualified for alternate careers:

> And the biggest fear I had going in was actually about I just didn't have the skills … So it was just this fear of the unknown – that was my biggest fear.

Some of the women remarked on the reluctance of many from academia to pursue a career "outside". Margaret reflected: "Industry has a very bad stigma attached to it." The women reported they had struggled with feeling they had failed or would be seen to have failed by their colleagues in academia. This situation was also reported by Haynes et al. (2016), who found ECRs in the UK struggled with being perceived by their academic colleagues as having failed; the challenges of working out what to do next and of potentially being over-qualified or under-skilled were similar for these women. The importance to the women of their identity as scientists, supported by our survey findings, contributed to the difficulty.

5.3.1.3 Consequences of the Decision

The new lives outside the STEMM research environment described by the eight women show they now have flexibility, security and ability to plan their future directions. All the women were all happy with their decisions to change careers and were content. They reported that they were now enjoying their new roles and felt both rewarded and recognised and had gained work-life balance. Many interviewees reflected on positive aspects of the change which are important to understand in this STEM culture where there is stigma about alternate careers.

The women, with the exception of Daisy, had moved to a diverse range of occupations as science professionals. Daisy was not yet working and was uncertain about where to go next. "I'm really in a quandary because there's part of me that thinks I can't do anything else**.**"In the meantime, she was enjoying time with her family while she recovered from the stresses of her previous work-life imbalance.

Pixie's comment below shows benefits of new work-life balance and job satisfaction that was typical of these women:

> they treat their employees really well and there's a big focus on gender diversity, cultural diversity and a lot of flexibility around family and workplace…I'm able to manage my own hours around childcare and … I know that my career won't be going backwards because of the time I take off to have children

Importantly, the women still valued their ability to "make a difference". As mentioned above, their identity as a scientist was important to all these women. Although the question was never asked, they all said that they loved science and they chose it as a career because they loved it supporting the findings about the "love of science" which was discussed in Chapter 4 and which came out strongly in the on-line survey as a contributor to job satisfaction. Most of the women had managed to put up with almost impossible situations to progress their careers such as in this example reported by Daisy (then 4 years postdoc):

> It was hard – I'd had [my child] by this point – but I didn't mind. I didn't mind that it was hard and that every waking moment was spent thinking about my work because I loved it so much.

All the women missed similar aspects of academic life, especially their interaction with other scientists, their independence and their freedom to pursue their special subjects. Daisy had some reservations: "I really felt like I'd lost my identity as a person but now what I miss more is just the enquiry – the knowing that I'll never know eats at me a bit."Nevertheless, they felt appreciated and respected and they felt they were useful. They now knew they had skills which were transferable to other careers.

In taking new career paths outside academic STEMM research these women have achieved work-life balance, security and ability to plan their futures. In spite of taking the risk of stepping off the "postdoctoral treadmill" (Edwards et al., 2011) of grants, papers, more grants, more papers and short-term contracts, they can progress in their careers without damaging their prospects. Many of the women have left their previous positions to specifically gain security and several wanted to work part-time to allow for their family commitments. My findings further support those of Haynes et al., 2016 who also examined the next careers for researchers in the UK who had left academia. They found the majority of ECRs had gone to careers as science professionals and also showed women had particularly wanted a better work-life balance and were pleased about their move from academia.

In conclusion, I found the women I interviewed now have fulfilling alternate careers outside of academia while, at the same time, they had retained their satisfaction with their identity as scientists.

5.3.2 Differences Between Genders or Family Situation with Respect to Considering Career Change

I looked further at intention to leave to examine whether there were major differences for men and women or for people with different family circumstances (with and without children).

Figure 38:

Stated Intention to Leave by Gender and by Whether there are Children at Home

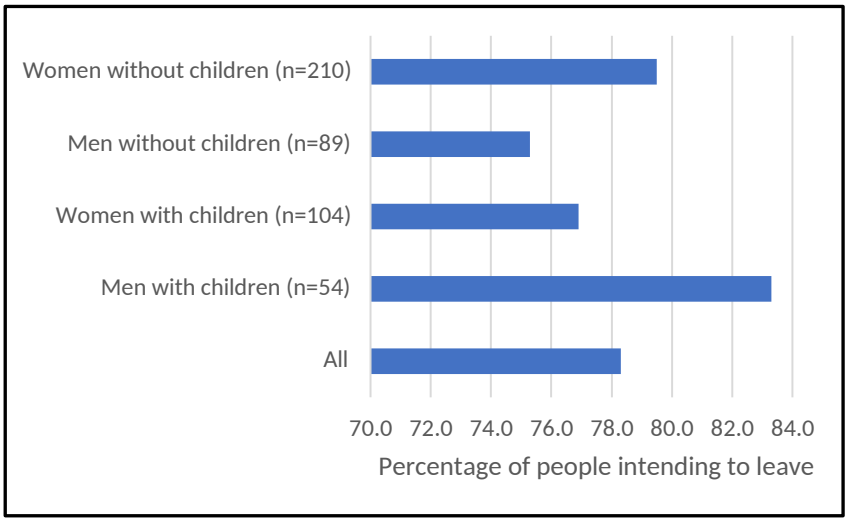


Figure 38 shows men with children appear to be much more likely to consider leaving than anyone else (83.3%), followed by women without children (76.9%). Men without children were least likely to have considered moving (75.3%) however these numbers are not statistically significant (Chi-square = 2.06, df= 1, p=0.151 Although aware that these differences are not statistically significant, I note it would be difficult to hypothesise about the meaning of this picture. It is possible that the women without children are considering leaving to have a family; perhaps the men with children have been longer in their careers and the stress and job insecurity are taking their toll.

Figure 39:

Respondents Who Selected "Job Insecurity" Compared by Gender and by Children at Home

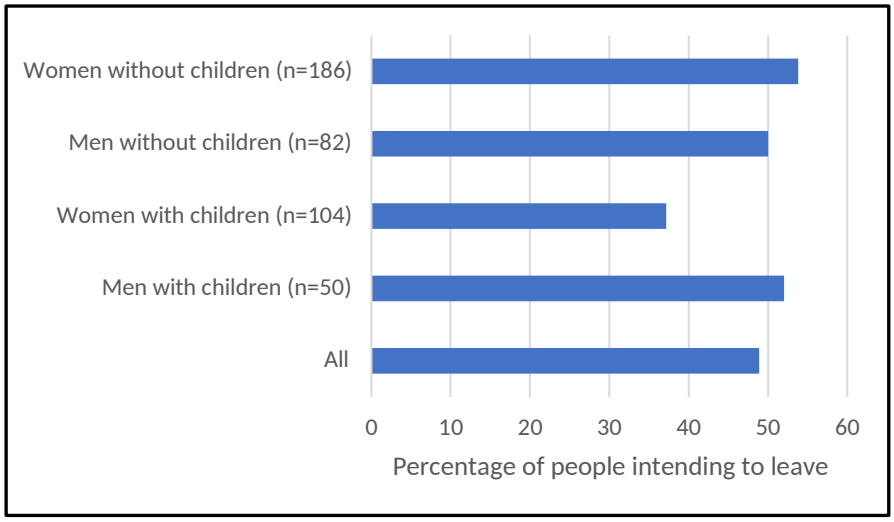


Figure 39 shows a break-up of the people who selected job security as the main reason they would be likely to leave. In this case the percentages for women without children (54%) and men with children (53%) are almost the same; curiously women with children had the lowest percentage (38%) of people likely to leave because of job insecurity. These percentages are not statistically significant (Chi-square = 3.524, df= 1, p=0.060).

Again noting these figures are not statistically significant, this somewhat unexpected pattern may indicate the women were less vulnerable to job insecurity as they are able to extend the length of contracts which are funded by grants due to part time work (27% women work part-time compared with 14% men), however I acknowledge this suggestion is conjecture and comes from my experience of many instances of this circumstance, rather than from hard evidence collected in the project.

5.4: Modelling Intention to Leave Using Quantitative Data

Having established from results of the on-line survey (see Figures 36 and 37 above) that many ECRs in Australia are either considering leaving their current role or actively intending to leave, I sought to investigate the factors contributing to this intention in more detail. As a first step, I conducted an analysis of the quantitative project data in order to model factors contributing to the intention to leave of ECRs by conducting a number of binary logistic regression analyses of the on-line survey data. In doing so, I hoped to establish whether factors identified in the literature were of the same consequence to participants in the on-line survey, and whether any additional factors might be identified.

In each case an individual's intention to leave was estimated using data from my on-line survey on factors expected, on the basis of my reading, to contribute to intention to leave. These included factors which pertain to workplace culture and work conditions (such as level of organisational support, including supervision and mentoring, and factors influencing work-life balance) as well as demographic factors such as gender, family responsibilities, nature of the employment and number of years postdoctoral. as discussed earlier in this chapter. I chose a different range of factors for each model, each of which will be described below, in order to establish whether any of the groupings of factors used for the model for job satisfaction had more influence than others for intention to leave.

5.4.1 Model One

Model One included the widest range of factors, listed in Table 28 below.

Table 28:

Model One: Variables Used in Logistic Regression for Intention to Leave

Question	Question Detail
Q2	What is the number of years since completion of your highest degree?
Q4	What is your gender?
Q11	Do you live with a partner?
Q13	Do you have any children under 18 living at home with you
Q15	Are you responsible for the care of any adult due to their ill-health, age or disability
	To what extent do you agree…
Q31-1	I am confident my work contributions are valued
Q31-2	I'm confident I can get research grants
Q31-3	I'm confident I can publish in good journals
Q31-4	Overall I find my work rewarding
Q31-5	I have good career or promotion opportunities
Q31-6	I have an unreasonable amount of administrative work
Q31-7	I have good job security
Q31-8	I have freedom to pursue my own research interests
Q31-9	I have adequate equipment and resources to do my job
Q31-10	I am satisfied with my level of income
Q31-11	I am able to influence decisions that affect me
Q31-12	I feel safe in my work environment/workplace
Q31-13	I am satisfied with my workplace's commitment to a diverse and inclusive workplace
	To what extent are you satisfied with…
Q32-1	The criteria for promotion
Q32-2	The culture of my workplace
Q32-3	The leadership and management of my workplace
Q32-4	Opportunities for attending conferences and study leave
Q32-5	Support for career development/professional development
Q32-6	Level of resources and equipment to do my job
Q32-7	Flexibility of working hours

For Model One, as described in Chapter 3, and shown in Table 28, I used the variables Q2 (years postdoc), Q4 (what is your gender), Q11 (do you have a partner), Q13 (do you have children at home), Q15 (do you have carer responsibilities), all the sub-questions from Q31 which are questions pertaining to job satisfaction and all questions from Q32 which are questions about workplace satisfaction. These particular questions were selected as they were

reflective of almost all the main factors reported in the literature as being relevant to intention to leave, namely demographics and job satisfaction (Miller & Feldman, 2015; Rosser, 2004). Although they had been identified in the literature as important, I did not include salary or organisational commitment; they had not emerged in this on-line survey as being factors of consequence.

Table 29:

Classification Table: Prediction after Step 23

Observed	Predicted	Percentage Correct
Intentleave	No	1.0
	Yes	100
Overall Percentage		82.6

Omnibus Tests after Step 23

Tests	Chi-square	df	Sig
Step	-2.433	1	0.119
Block	39.217	3	0.000
Model	39.217	3	0.000

Model Summary after Step 23

Cox & Snell R Square	Nagelkerke R Square
0.068	0.112

Table 29 shows the prediction accuracy of Model One. The Chi-square is significant for the model row therefore these predictors in combination significantly improve the predictive accuracy of my model of intention to leave ($\chi 2$ =32.217, df = 3, p-value = 0.000).

Table 30:

Model One: Results of Logistic Regression for Intention to Leave

Test	**Backward stepwise @step 23)**	
Variables included in the Model	**Significance**	**Exp(B)**
Q2: # years postdoc	0.000	1.588
Q31-5: I have good career prospects /opportunities	0.003	1.396
Q31-11: Ability to influence decisions that affect me	0.018	1.339
Variables not included in the Model		
Q4 What is your gender?		
Q11: Do you live with a partner		
Q13 Do you have any children under 18 living at home with you		
Q15: Are you responsible for care of any adult		
Q31-1: I am confident my work contributions are valued		
Q31-2 I'm confident I can get research grants		
Q31-3 I'm confident I can publish in good journals		
Q31-4: Overall I find my work rewarding		
Q31-6: I have an unreasonable amount of administrative work		
Q31-7: I have good job security		
Q31-8 I have freedom to pursue my own research interests		
Q31-9 I have adequate equipment and resources to do my job		
Q31 -10: I am satisfied with my level of income		
Q31-12: I feel safe in my workplace		
Q31-13: I am satisfied with my workplace's commitment to a diverse and inclusive workplace		
To what extent are you satisfied with…		
Q32-1 The criteria for promotion		
Q32-2: I am satisfied with the culture of my workplace		
Q32-3 The leadership and management of my workplace		
Q32-4: Opportunities for attending conferences		
Q32-5 Support for career development/professional development		
Q32-6 Level of resources and equipment to do my job		
Q32-7: Flexibility of working hours		

As demonstrated in Table 30 the logistic regression for Model One showed the most significant factor predicting intention to leave is number of years postdoctoral. The odds ratio Exp(β)=1.588 for number of years postdoctoral indicates that for every extra time period postdoctoral (two years) the likelihood of leaving increases by 59%. Assuming the link between intention to leave and job satisfaction holds true, this supports the work of Miller & Feldman (2015) who showed ECRs reported greater satisfaction the more recently they had begun their first postdoctoral appointment (b = –0.068, p = 0.008), confirming that dissatisfaction increases over time spent as a "postdoc". The questions "I have good career prospects /opportunities" and "ability to influence decisions that affect me" are also significant, suggesting that for each time period the respondents are respectively 39.6% and 33.9% more likely to leave. Perhaps this suggests that the people who were confident at the beginning of their career, and still feel able to influence decisions relating to them, feel they have the freedom to move elsewhere.

This model was very accurate at predicting intention to leave (100%), but poor at predicting intention to stay (Cox and Snell R square = 0.068, Nagelkerke R square = 0.112) as demonstrated by the R square factors which indicate accuracy for intention to stay is only 6.8% or 11.2%. It is of interest to note that demographic factors such as age, gender and family situation were not significant in predicting intention to leave and nor were the many matters included relating to the work and workplace culture.

Subsequently I ran three more logistic regression models in order to determine whether the elements of the model developed for factors related to job satisfaction (method reported in Chapter 3, Section 3.9.1.2, results reported in Chapter 4, Section 4.4) had a particular relevance to intention to leave. These models are each described below.

5.4.2 Model Two

For Model Two, I examined personal factors against intention to leave, and, as in the model for job satisfaction, selected questions reflective of the respondents' personal views, and questions which indicate the influence of others on the respondent.

Table 31:

Model Two Personal Factors: Variables Used in Logistic Regression for Intention to Leave

Question	Question Detail
Factors About "Me "	
Q44	How beneficial was the mentoring
Q55	Upon the completion of your highest degree, do you agree you were confident in your career prospects
Q74-1	This is a poor time for any young person to begin an academic career in my field
Q74-2	If I had it to do over again, I would not become an academic
Q74-3	My job is a source of considerable personal strain
Factors Reflecting Influence of Others on "Me"	
Q36-6	Impacted by attitude re age
Q36-7	Impacted by attitude re gender
Q36-8	Impacted by attitude re ethnicity
Q37-2	Impacted by harassment based on power position
Q37-3	Impacted by lack of support
Q48-1	How would you rate your review's usefulness

The factors selected for Model Two are shown in Table 31 above.

Table 32:

Classification Table: Prediction after Step 10

Observed	Predicted	Percentage Correct
Intentleave	No	12.5
	Yes	97.5
Overall Percentage		77.8

Omnibus Tests after Step 10

Tests	Chi-square	df	Sig
Step	-2.407	1	0.121
Block	20.094	2	0.000
Model	20.094	2	0.000

Model Summary after Step 10

Cox & Snell R Square	Nagelkerke R Square
0.093	0.140

Table 32 illustrates Model Two's ability to predict intention to leave. The Chi-square is significant for the Model row therefore these predictors in combination significantly improve the predictive accuracy of my model of intention to leave ($\chi 2$ =20.094, df = 2, p-value = 0.000). As for Model One, Model 2 predicts intention to leave accurately (97.5%) but prediction of intention to stay is poor (R squares 9.3% and 14% accurate).

Table 33:

Model Two Personal Factors: Results of Logistic Regression for Intention to Leave

Test	**Backward stepwise @step 10)**	
Variables included in the Model	**Significance**	**Exp(B)**
Q55 Do you agree you were confident in your career prospects	0.089	1.265
Q74-3 my job is a source of considerable personal strain	0.000	1.787
Variables not included in the Model		
To what extent have the following characteristics of your workplace culture impacted you…		
Q36-6 Impacted by attitude re age		
Q36-7 Impacted by attitude re gender		
Q36-8 Impacted by attitude re ethnicity		
Q37-2 Impacted by harassment based on power position		
Q37-3 Impacted by lack of support		
Q44 How beneficial was the mentoring		
Q48-1 How would you rate your review's usefulness		
Q74-1 This is a poor time for any young person to begin an academic career in my field		
Q74-2 If I had it to do over again, I would not become an academic		

As demonstrated in Table 33 Model Two showed the most significant questions were "My job is a source of considerable personal strain" and "Do you agree you were confident in your career prospects upon the completion of your highest degree". Exp(B) =1.787 for personal strain indicates that the strain increases the likelihood of leaving by 79% every two years. I note the Exp(B) =1.265 for "Do you agree you were confident in your career prospects", which indicated the respondents are 26.5% more likely to leave in every time period, is similar to the number for Model One. As suggested for Model One, it seems people who are confident feel able to be more mobile and are likely to move to gain a more desirable position.

Again, it was interesting to see that the questions investigating workplace culture, including the less attractive aspects of the work environment such as lack of support or impact

of harassment, the value of mentoring and receiving a personal review and the group of broad satisfaction questions did not significantly influence intention to leave for the respondents.

5.4.3 Model Three

For Model Three I selected questions which related to impact of choices made by the institutions and job conditions to measure against intention to leave.

Table 34:

Model Three Institutional Factors: Results of Logistic Regression for Intention to Leave

Question	Question Detail
Q2	No. years postdoctoral
Q17	How many hours per week do you work in your workplace
Q18	How many hours per week do you undertake work at home
Q19	What is your employment fraction
Q23	In which manner are you employed
Q24	If you are on a fixed term contract what is the length of fixed term contract
Q25	How many postdoctoral appointments have you had
Q31-13	I am satisfied with my workplace's commitment to a diverse and inclusive workplace
	To what extent are you satisfied with …
Q32-1	The criteria for promotion
Q32-3	The leadership and management

Table 34 shows the questions which had been utilised in the model for job satisfaction (method reported in Chapter 3, Section 3.9.1.2, results reported in Chapter 4, Section 4.4) within "institutional choices" and "working conditions". I also included "number of years postdoctoral" in case there was an influence on institutional factors which related to years postdoctoral.

Table 35:

Classification Table: Prediction after Step 7

Observed	Predicted	Percentage Correct
Intentleave	No	0
	Yes	99.7
Overall Percentage		80.9

Omnibus Tests after Step 7

Tests	Chi-square	df	Sig
Step	-.938	1	0.333
Block	29.166	4	0.000
Model	29.166	4	0.000

Model Summary after Step 7

Cox & Snell R Square	Nagelkerke R Square
0.067	.107

Table 35 illustrates the prediction accuracy of Model Three. The Chi-square is significant for the model row therefore these predictors in combination significantly improve the predictive accuracy of my model of intention to leave ($\chi 2$ =29.166, df = 4, p-value = 0.000). As for Models One and Two, Table 35 shows Model Three predicts intention to leave accurately (99.7%) but prediction of intention to stay is very poor (R square 6.7% accurate and 10.7% accurate).

Table 36:

Model Three: Institutional Choices Factors: Results of Logistic Regression for Intention to Leave

Test	**Backward stepwise @step 7**	
Variables included in the Model	**Significance**	**Exp(B)**
Q2 What is the number of years since completion of your highest degree	0.014	1.512
Q24 If you are on a fixed term contract what is the length of fixed term contract	0.069	0.659
Q25 How many postdoctoral appointments have you had	0.044	1.432
Q32-3 Satisfaction with the leadership and management	0.014	1.313
Variables not included in the Model		
Q17 How many hours per week do you work in your workplace		
Q18 How many hours per week do you undertake work at home		
Q19 What is your employment fraction		
Q23 In which manner are you employed		
Q31-13 I am satisfied with my workplace's commitment to a diverse and inclusive workplace		
Q32-1 Satisfaction with the criteria for promotion		

As indicated in Table 36, Model Three showed four significant factors: the number of postdoctoral appointments held by the respondents, satisfaction with leadership and management of their institution, the length of their fixed term contract and the number of postdoctoral appointments they have held. For fixed term contract, Exp(B) =0.659 indicates that respondents will be 34.1% less likely to leave if they have a longer contract. A high number of postdoctoral appointments is likely to be significant because a larger number of positions will be an indication of disruption and the need to find more appointments; Exp(B) =1.432 indicates that they will be 43.2% more likely to leave if they have already held numerous postdoctoral contracts. Satisfaction with leadership and management appears to be a problem; Exp(B) =1.313, suggests that they will be 31.3% more likely to leave during each

two-year time period as a consequence. Last, as for Model One, number of years postdoctoral is a significant predictor with Exp(B) =1.512, indicating that the respondents will be 51.2% more likely to leave in each subsequent time period.

Again, Model Three is poor at predicting intention to stay however it does show that the long hours worked, either at the workplace or home, and the employment fraction do not significantly influence intention to leave, and nor do the criteria for promotion or the institution's commitment to a diverse and inclusive workplace.

5.4.4 Model Four

For Model Four I grouped together all the significant factors from Models One, Two and Three and used the combination of these factors to model intention to leave.

Table 37:

Model Four: Most Important Variables Logistic Regression for Intention to Leave

Question	Question Detail
Q2	What is the number of years since completion of your highest degree
Q25	How many postdoctoral appointments have you had
Q31-11	Ability to influence decisions that affect me
Q32-1	I am satisfied with the criteria for promotion
Q32-3	I am satisfied with the leadership and management of my workplace
Q74-3	My job is a source of considerable personal strain

Table 37 shows the six questions used for Model Four. Note there is a very low correlation between the number of years post doc and the number of post-doctoral positions so including both of these variables as explanatory does not create issues of multicollinearity ($r = 0.351$, $p = 0.000$).

Table 38:

Classification Table: Prediction After Step 4

Observed	Predicted	Percentage Correct
Intentleave	No	14
	Yes	96.6
Overall Percentage		78.2

Omnibus Tests after Step 4

Tests	Chi-square	df	Sig
Step	-2.020	1	0.155
Block	44.397	3	0.000
Model	44.397	3	0.000

Model Summary after Step 4

Cox & Snell R Square	Nagelkerke R Square
0.094	0.144

Table 38 provides detail of the prediction accuracy of Model Four. The Chi-square is significant for the model row therefore these predictors in combination significantly improve the predictive accuracy of my model of intention to leave ($\chi 2$ =44.397, df = 3, p-value = 0.000). While the accuracy of prediction for intention to stay is still poor, Table 38 shows it is a little more accurate than previous models (R square 9.4% and 14.4 % accurate).

Table 39:

Model Four Most Important Factors: Results of Logistic Regression for Intention to Leave

Test	Backward conditional @Step 3	
Variables included in the Model	**Significance**	**Exp(B)**
Q2 What is the number of years since completion of your highest degree	0.001	1.591
Q31-11 I am able to influence decisions that affect me	0.053	1.272
Q74-3 My job is a source of considerable personal strain	0.000	1.540
Variables not included in the Model		
Q25 How many postdoctoral appointments have you had		
Q32-1 I am satisfied with the criteria for promotion		

Q32-3 I am satisfied with the leadership and management

As mentioned above, Model Four provided the most reliable results. Table 39 shows "my job is a source of considerable personal strain" (Exp(B) =1.540, indicates that respondents will be 54% more likely to leave) and the number of years since completing the highest degree (Exp(B) =1.591, indicates that they will be 59.1% more likely to leave) were most relevant, followed by ability to influence decisions (Exp(B) =1.272, indicates that they will be 27.2% more likely to leave) which affect the respondent. Putting these three most significant factors together, we find that as time passes since starting as an ECR the personal strain develops and intention to leave intensifies, with the likelihood of departure increasing by one and a half times every year. This intention to leave arising from the passing of time and the personal strain appears to be is balanced, to an extent, by the ability to make decisions which affect oneself as the intention to leave is half the rate when the respondents are able to influence decisions which concern them.

In Model Four satisfaction with leadership and management and criteria for promotion as well as the number of postdoctoral appointments have each lost their significance, overcome by the other factors.

5.4.5 Summary of Work on Logistic Regression on Models

I created these four models for factors influencing intention to leave to ascertain whether data collected in my on-line survey supported views from the literature, particularly with reference to the link between job satisfaction and intention to leave. I first employed data from many of the questions used in the structural equation modelling to create a model for job satisfaction (reported in Chapter 4) and then broke those factors into components for Models Two and Three before selecting the most significant factors for Model Four. All models were

statistically significant for intention to leave, however predicting intention to stay (a much more complicated topic) was poor.

Factors which have been discussed in the literature such as demographic characteristics (such as age, gender, family responsibilities) were found not to be significant and nor were level of organisational support (including supervision and mentoring) or factors influencing work-life balance). Instead, the dominant factors were simply time spent in postdoctoral positions and its associated stress, together with a factor which leads to the ECRs having some control, namely the ability to influence decisions that affect them.

5.4.6 Comparison with Other Work

We can compare this work on intention to leave in this study with that of Ryan et al. (2012) who used binary logistic regression techniques on data collected in a survey of tenured and tenure/track academics at large, public research university in the midwestern United States to examine the relationship between various research-based factors and intention to leave by integrating factors identified in the literature for employee turnover in the general workplace as well as those identified as important for academics. Ryan et al. (2012) identified workplace stress, being in a ‘‘soft-pure’’ discipline, (such as arts or humanities), fewer years of service at the university, and higher research productivity as key predictors of academic staff having considered leaving for another institution. They found key predictors for staff having considered leaving academia altogether were being in a ‘‘hard-applied’’ discipline, e.g. physics, not having a spouse or partner, a perceived lack of support, a perceived lack of fit, stress of family commitments, and dissatisfaction with certain aspects of the actual position.

Note that “years at institution” is not necessarily the same as “years postdoctoral”, so it is possible Ryan at al. are measuring something quite different, particularly as ECRs in

Australia are required to move so often. Because Ryan et al. (2012) are looking at academic staff at all levels and in all disciplines, it is likely that they have included senior people who may have been attracted to other universities, others who are satisfied because they are familiar and comfortable with their workplace after a long period of service. They are also looking at an environment where there are likely to be many job opportunities outside academia within industry, which is not necessarily the same in Australia.

It is interesting that feeling valued is an important factor for intention to stay, as opposed to leave, emerging from this analysis, but it is not mentioned often in either the free text answers or interviews. I note Q31-1 "I am confident my work/contributions are valued by my employer" in the on-line survey shows only 61% of respondents agree their work is valued by their employer.

5.5 Conclusions for Motivations for ECRs to Leave the Sciences

My findings show job insecurity and the constant need to apply for further funding, which actually interferes with the ECRs' ability to do research, together with the stresses and strains of overall hard work are eventually viewed by the ECRs as personal sacrifices. The time comes when the sacrifice is too much, and the decision is taken to leave. As had been expected, the most significant pointer to intention to leave is number of years postdoctoral.

In Chapter 6 I will summarise my findings about the ECR workplace experience, including those factors contributing to job satisfaction and intention to leave. These findings inform recommendations which could help retain highly trained scientists in academic research, or at least in science, in Australia.

Chapter 5 References

Ackers, L. (2008). Internationalisation, Mobility and Metrics: A New Form of Indirect Discrimination? Minerva, 46(4), 411–435. https://doi.org/10.1007/s11024-008-9110-2

Ashford, S. J., Lee, C., & Bobko, P. (1989). Content, Causes, and Consequences of Job Insecurity: A Theory-Based Measure and Substantive Test. The Academy of Management Journal, 32(4), 803–829. JSTOR. https://doi.org/10.2307/256569

Basak, S. K., & Govender, D. (2015). Theoretical Framework Of The Factors Affecting University Academics Job Satisfaction. International Business & Economics Research Journal (IBER), 14(2). https://doi.org/10.19030/iber.v14i2.9167

Bashir, B., & Gani, A. (2019). Testing the effects of job satisfaction on organizational commitment. Journal of Management Development. https://doi.org/10.1108/JMD-07-2018-0210

Bell, S., & Yates, L. (2015). Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne. https://womeninscienceaust.org/2014/06/15/women-in-the-scientific-research-workforce-identifying-and-sustaining-the-diversity-advantage/

Bentley, P., Coates, H., Dobson, I., Goedegebuure, L., & Meek, V. L. (2013). Factors associated with job satisfaction amongst Australian university academics and future workforce implications. In Job Satisfaction around the Academic World. https://link.springer.com/chapter/10.1007/978-94-007-5434-8_3

Bexley, E., James, R., & Arkoudis, S. (2011). The Australian Academic Profession in Transition: Addressing the challenge of reconceptualising academic work and regenerating the academic workforce. Centre for Study of Higher Education, Commissioned by Department of Education, Employment and Workplace Relations. https://melbourne-

cshe.unimelb.edu.au/__data/assets/pdf_file/0010/1490923/The_Academic_Profession_in_Transition_Sept2011.pdf

Bludorn, A. C. (1982). A Unified Model of Turnover from Organizations. Human Relations, 35(2), 135–153. https://doi.org/10.1177/001872678203500204

Browning, L., Thompson, K., & Dawson, D. (2016). It takes a village to raise an ECR: Organisational strategies for building successful academic research careers. International Journal for Researcher Development, 7(2). www.emeraldinsight.com/2048-8696.htm

Browning, L., Thompson, K., & Dawson, D. (2017). From early career researcher to research leader: Survival of the fittest? Journal of Higher Education Policy and Management, 39(4), 361–377. https://doi.org/10.1080/1360080X.2017.1330814

Cantwell, B. (2011). Transnational Mobility and International Academic Employment: Gatekeeping in an Academic Competition Arena. Minerva, 49(4), 425–445. https://doi.org/10.1007/s11024-011-9181-3

Christian K, Johnstone C, Larkins J, Wright W, Doran MR. A survey of early-career researchers in Australia. Rodgers P, Deathridge J, Lijek RS, Rolf H, Hussain T, editors. eLife. 2021 Jan 11;10:e60613

Coates, H., Dobson, I., Edwards, D., Friedman, T., Goedegebuure, L., & Meek, L. (2009). The Attractiveness of the Australian Academic Profession: A comparative analysis.

Coates, H., & Goedegebuure, L. (2007). The Australian Academic Profession in 2007 Survey Methodology and Response Analysis. Australian Council for Educational Research.

Coates, H., & Goedegebuure, L. (2010). The Real Academic Revolution: Why we need to reconceptualise Australia's future academic workforce. L H Martin Institute. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0007/2565070/Why-we-need-to-reconceptualise-Australias-future-academic-workforce.pdf

Coates, H., & Goedegebuure, L. (2012). Recasting the academic workforce: Why the attractiveness of the academic profession needs to be increased and eight possible strategies for how to go about this from an Australian perspective. Higher Education, 64(6), 875–889.

Coates, H., Goedegebuure, L., & Meek, V. L. (2015). Increasing the Attractiveness of the Academic Profession: A Challenge for Management. In U. Teichler & W. K. Cummings (Eds.), Forming, Recruiting and Managing the Academic Profession (pp. 297–315). Springer International Publishing. https://doi.org/10.1007/978-3-319-16080-1_16

Coates, H., Goedegebuure, L., Van der Lee, J., & Meek, L. (2008). The Australian academic profession in 2007: A first analysis of the survey results. Australian Council for Educational Research.

Edwards, D., Bexley, E., & Richardson, S. (2011). Regenerating the Academic Workforce. The careers, intentions and motivations of higher degree research students in Australia. Findings of the National Research Student Survey. Australian Council for Educational Research. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0009/1490940/RAW_Combined.pdf

Edwards, D., & Smith, T. F. (2008). Supply, demand and approaches to employment by people with postgraduate research qualifications in science and mathematics: Consultation Report. Australian Council for Educational Research. https://www.voced.edu.au/content/ngv%3A52019

Finkelstein, M. J. (1984). The American Academic Profession: A Synthesis of Social Scientific Inquiry since World War II. Ohio State University Press.

Foley, D. J., Selfa, L. A., & Grigorian, K. H. (2019). InfoBrief: Number of Women with U.S. Doctorates in Science, Engineering, or Health Employed in the United States More Than Doubles since 1997.

Gardner, S. K. (2012). "I Couldn't Wait to Leave the Toxic Environment": A Mixed Methods Study of Women Faculty Satisfaction and Departure From One Research Institution. NASPA Journal About Women in Higher Education, 5(1), 71–95. https://doi.org/10.1515/njawhe-2012-1079

Gascoigne, T. (2012). Career support for researchers: Understanding needs and developing a best practice approach. Australian Council of Learned Academies Commissioned by the Department of Industry, Innovation, Science, Research and Tertiary Education.

Grinstein, A., & Treister, R. (2018). The unhappy postdoc: A survey based study. F1000Research, 6, 1642. https://doi.org/10.12688/f1000research.12538.2

Haynes, K., Metcalf, J., & Yilmaz, M. (2016). What Do Research Staff Do Next? Vitae.

Johnsrud, L. K., & Rosser, V. J. (2002). Faculty members' morale and their intentions to leave: A multilevel explanation. The Journal of Higher Education, 71(1), 34–59.

Laudel, G., & Bielick, J. (2019). How do field-specific research practices affect mobility decisions of early career researchers? Research Policy, 48(9), 103800. https://doi.org/10.1016/j.respol.2019.05.009

Lee, T. W., & Mowday, R. T. (1987). Voluntarily leaving an organization: An empirical investigation of Steers and Mowday's model of turnover. Academy of Management Journal, 30(4), 721–743. https://doi.org/10.2307/256157

Manger, T., & Eikeland, O.-J. (1990). Factors Predicting Staff's Intentions to Leave the University. Higher Education, 19(3), 281–291. JSTOR.

McAlpine, L., & Emmioğlu, E. (2015). Navigating careers: Perceptions of sciences doctoral students, post-PhD researchers and pre-tenure academics. Studies in Higher Education, 40(10), 1770–1785. https://doi.org/10.1080/03075079.2014.914908

McCain, B. E., O'Reilly, C., & Pfeffer, J. (1983). The Effects of Departmental Demography on Turnover: The Case of a University. Academy of Management Journal, 26(4), 626–641. https://doi.org/10.5465/255911

McDonnell, J. (2019). Step up to leadership for mid-career growth. Nature. https://doi.org/10.1038/d41586-019-01936-7

McInnes, C. (1999). The work roles of academics in Australian universities. Department of Education, Training and Youth Affairs.

Miller, J. M., & Feldman, M. P. (2015). Isolated in the Lab: Examining Dissatisfaction with Postdoctoral Appointments. The Journal of Higher Education, 86(5), 697–724. https://doi.org/10.1353/jhe.2015.0029

National Tertiary Education Union. (2017). NTEU State of the Uni Survey 2017. Report 1: Overview by NTEU. National Tertiary Education Union. https://issuu.com/nteu/docs/sotus_2017_report_1_overview

Podsakoff, P. M., MacKenzie, S. B., Paine, J. B., & Bachrach, D. B. (2000). Organizational Citizenship Behaviors: A Critical Review of the Theoretical and Empirical Literature and Suggestions for Future Research. Journal of Management, 26(3), 516–563.

Powell, K. (2016). Young, Talented and Fed Up. Nature, 538, 446–449.

ResearchGate. (2020). The State of Scientific Recruitment. https://solutions.researchgate.net/wp-content/uploads/2020/02/Scientific_Recruitment_with_ResearchGate.pdf

Rosser, V. J. (2004). Faculty Members' Intentions to Leave: A National Study on Their Worklife and Satisfaction. Research in Higher Education, 45(3), 285–309. https://doi.org/10.1023/B:RIHE.0000019591.74425.f1

Ryan, J. F., Healy, R., & Sullivan, J. (2012). Oh, won't you stay? Predictors of faculty intent to leave a public research university. Higher Education, 63(4), 421–437. https://doi.org/10.1007/s10734-011-9448-5

Shine, J., Bradlow, H., O'Reilly, S., & Godfrey, B. (2019). Women in STEM Decadal Plan (Australian Academy of Science) (p. 62). Australian Academy of Science. https://www.science.org.au/support/analysis/decadal-plans-science/women-in-stem-decadal-plan

Smart, J. C. (1990). A causal model of faculty turnover intentions. Research in Higher Education, 31(5), 405–424.

Walton, C. (2016). Best and Brightest—Advancing Medical Research—2016 Medical Research Institute Sector Survey Report. Professional Scientists Australia. http://www.professionalsaustralia.org.au/mri/advocacy/campaigns/medical-researchers/

Wellcome Trust. (2020). What researchers think about the culture they work in. Wellcome Trust. https://wellcome.org/reports/what-researchers-think-about-research-culture

Zusi, K. (2016). Life Sciences Salary Satisfaction Survey. The Scientist Magazine. https://www.the-scientist.com/?articles.view/articleNo/47311/title/2016-Life-Sciences-Salary-Survey/

Chapter 6|

Findings from the Project and Recommendations for Change

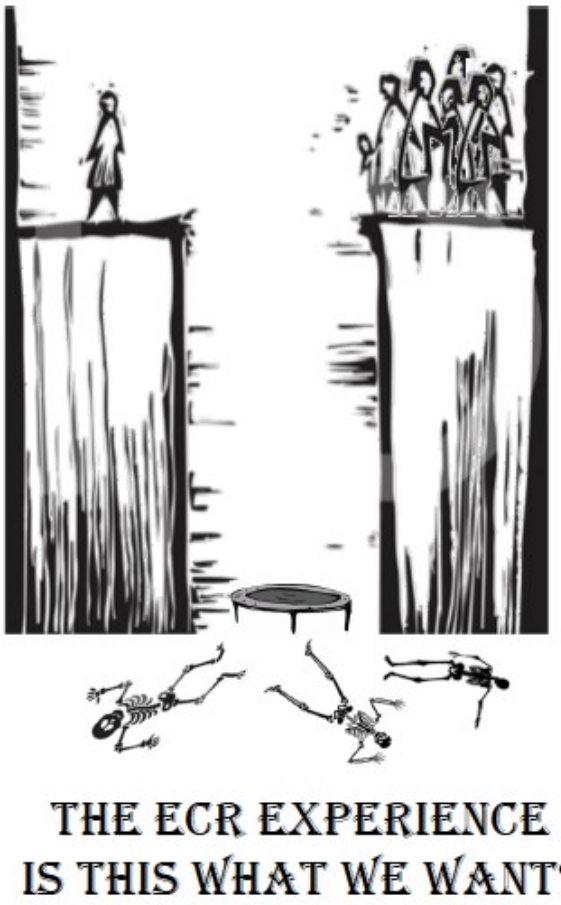


Image included with permission of Prof Don Newgreen

6.1 Introduction

The purpose of Chapter 6 is to bring together the findings from the different elements of my project and to offer recommendations for change.

I first present the findings in five sections: Section 6.2.1 addresses understanding the workplace from the perspective of ECRs in STEMM and Section 6.2.2 discusses identification of a need for more training and career planning and, necessarily, incorporates some results relating to training and career planning. These were expected outcomes from the project. The remaining sections address tangential findings which were not anticipated. Section 6.2.3 discusses the detrimental influence of "gatekeepers" on research, Section 6.2.4 shows the benefit for "insiders" to conduct research within universities and Section 6.2.5 identifies a need for universities to improve communication with outsiders. Although strictly speaking not a results chapter, Section 6.2 includes some results which do not comfortably sit within Chapters 4 or 5.

Section 6.3 of Chapter 6 presents my recommendations for identifying and addressing some of the challenges of ECRs; these recommendations are similarly divided into sections. Section 6.3.1 asks why action has not been taken consequent to previous reports. Section 6.3.2 calls for improved institutional culture; Section 6.3.3 requests institutions to address inequity and Section 6.3.4 for them to provide more professional development. Section 6.3.5 suggests changing the ways we measure impact. Sections 6.3.6 and & 6.3.7 address the tangential findings and ask institutions to re-consider the need for gatekeeper approval and improve access for outsiders to university information.

Finally, Section 6.4 briefly mentions progress as a consequence of this project and Section 6.5 Afterword discusses the implications to the sector of COVID-19. Section 6.7

concludes the thesis with comments from members of the Australian research community who endorse the value and importance of this work.

This PhD project has added to the existing body of literature on the work and workplace experiences of those employed in research positions in STEMM disciplines in universities and research institutes in Australia, as viewed through the eyes of early-career researchers. This project has provided a unique mixed methods analysis of variables which contribute to the job satisfaction of those researchers and their intention to stay in, or leave, the academic research environment. The mixed methods approach has brought us a more holistic view of the workplace for these ECRs than has previously been available and has provided us with a deeper understanding of the workplace experience. The development and use of the conceptual framework model, built on those of Rosser (Rosser, 2004, 2005; Rosser & Tabata, 2010) and Basak & Govender (2015) now provides a more nuanced view of the complex processes and contexts that contribute to both job satisfaction and intention to leave within the academic research environment in STEMM disciplines. Job satisfaction and intention to leave cannot readily be understood from analyses of big picture statistics, nor from the perspective of solitary variables such as percentages of the workforce for each gender, but instead must be examined in light of the complexity of many contexts.

This work does not propose to address, beyond acknowledgement, the shortage of funding which underlies the concerns about lack of job security, (discussed in the literature review in Chapter 2 and then in Chapter 4), however the lack of stable funding and its consequent job insecurity are clearly the greatest barrier to a successful career in academic research in the sciences in Australia (see Chapters 4 and 5). The pressures brought about from this lack of funding, which oppose the satisfaction the researchers receive from doing their actual work, contribute to a landscape which is full of problems. It is telling that the most

significant factor contributing to researchers actually leaving the research environment, as discussed in Chapter 5, is the number of years postdoctoral: very few of these researchers are actually able to stay in their chosen profession.

This work has identified:

- the most significant problems, from the perspective of the ECRs
- the reasons which might cause/has caused them to leave a career in the sciences
- some potential remedies, again from the perspective of the ECRs.

6.2: Findings from this Work

This research has shown us (in Chapters 4 and 5) that those ECRs who have the opportunity to take a postdoctoral appointment that immerses them in interesting research, and who wish to pursue an academic research career may find at least their first appointment satisfactory. This supports the view of those surveyed by Miller & Feldman (2015) who show that after the first few years the situation deteriorates, and it is likely that the desired research career will only be attainable for a very few. This is discussed in Chapters 4 and 5 and illustrated in Figures 20 to 23. The uncertainty is clearly very damaging to the well-being of the researchers Christian et al. (2021) and to the future of academic research in STEMM fields in Australia; a view recently supported by Climie et al. (2020).

This project has contributed to understanding of a range of topics connected with the workplace experiences of ECRs in STEMM in Australia. It has provided a deeper knowledge of the workplace experience of ECRs from the perspective of ECRs and factors contributing to their job satisfaction (see Chapter 4) as well as factors contributing to intention to leave (Chapter 5). Regrettably, it has identified the existence of many toxic workplaces Christian et al. (2021) and prevalence of questionable research practices (Christian et al., 2020a) and has

uncovered the need for better supervision and mentoring, and for more professional development which will be discussed below. On a largely unrelated tangent, it has also explored the consequences of the need for "gatekeeper approval" (Chapter 3, Section 3.8.1.1) on recruitment, questioned an anomaly in the practices of Human Research Ethics Committees (Christian et al., 2019) and identified a need for universities to better communicate with those "outside" (see Chapter 3).

These matters are summarised in more detail below.

6.2.1 Findings: Understanding the Workplace from the Perspective of ECRs in STEMM

As described in Chapter 3, in conducting this mixed methods project I have surveyed the opinions of 658 ECRs from a broad range of institutions and disciplines across Australia, interviewed, in depth, eight women who had recently left academic research for other occupations, conducted a focus group discussion and gathered information, recorded in a journal, while I went about my work as a Research Manager. In collecting, analysing and triangulating this data I have been able to build a clear picture of the challenges facing ECRs in the sciences in Australia, as suggested by the project title, and have addressed the research questions.

6.2.1.1 Identification of Factors Contributing to Job Satisfaction

The work which modelled factors contributing to job satisfaction discussed in Chapter 4 has identified the external and internal factors which contribute to the satisfaction of ECRs working in an environment of job insecurity. It became clear that the most influential factors found to contribute to job satisfaction (or lack of satisfaction) for Australian ECRs in STEMM were job insecurity, number of years postdoctoral, workplace stress and lack of work-life balance, family situation, the need to relocate, lack of institutional support and

questionable research practices. I pose, below, a revised framework of job satisfaction based on the previous work of Rosser (Rosser, 2004, 2005; Rosser & Tabata, 2010) and Basak & Govender (2015) which better fits the research environment of ECRs in STEMM disciplines in Australia.

6.2.1.2 New Framework for Job Satisfaction and Intention to Leave

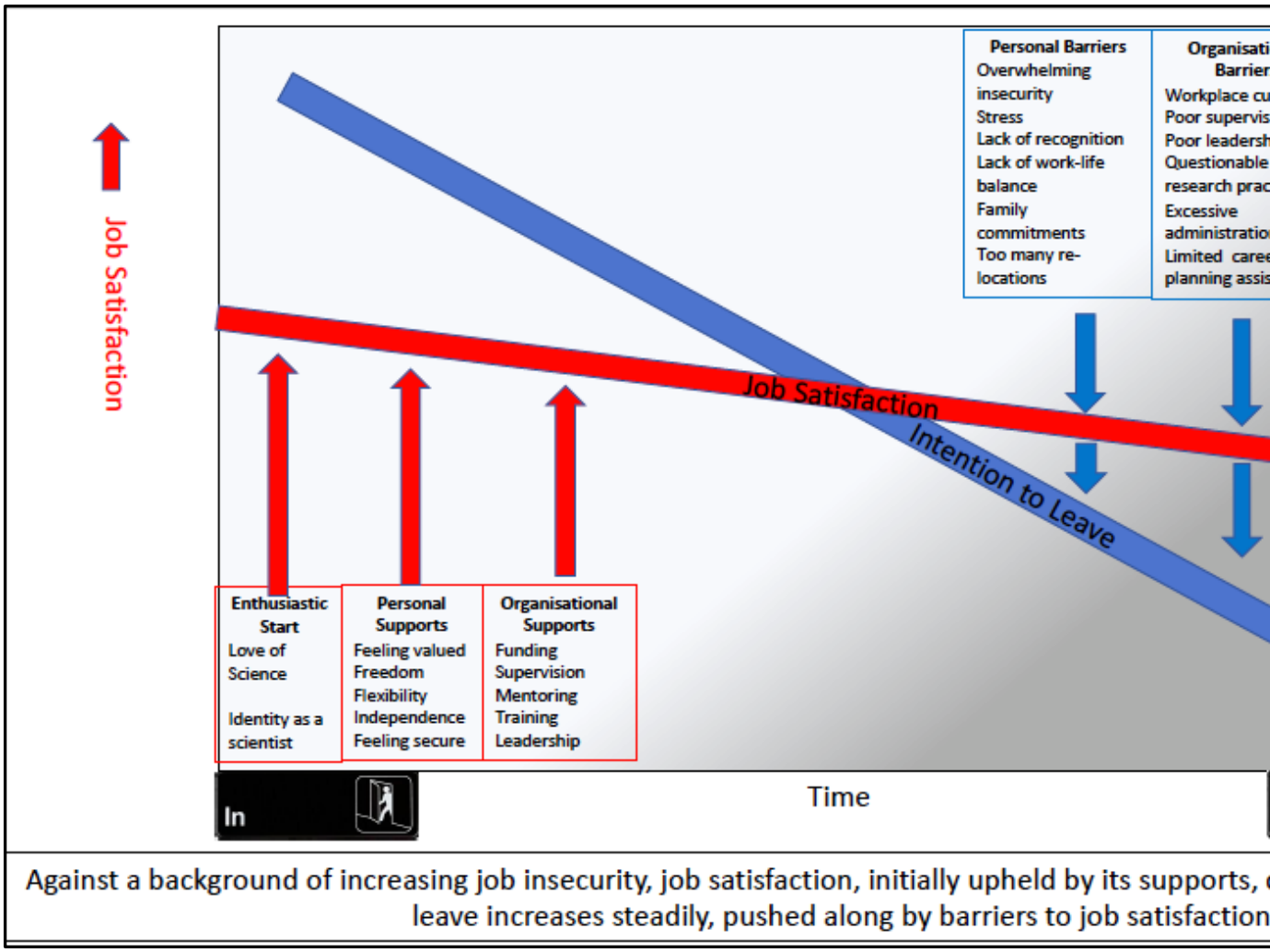
Rosser's model of job satisfaction (Rosser, 2004) shows links between worklife, satisfaction and intention to leave, all of which are influenced by demographics, however, as shown in Chapters 4 and 5, demographics appear to hold little influence within this cohort. There were minimal differences in satisfaction across broad demographic characteristics such as gender, country of birth or age. Another point of difference between Rosser's model and the proposed model emerging from this project are factors of academic life which can challenge job satisfaction. For Rosser these included factors which relate to life of a general academic, such as "committee and service work" and "advising and course load" which did not emerge as issues from my data, and nor does salary. While they may well be issues, there are others which my work suggests are of greater significance including job insecurity, stress and simply the passing of time (measured as years postdoctoral). The framework of Basak and Govender (2015) illustrates the importance of many factors which also show as significant in my findings, however those placed in "Other", including job security, workload, work burden and motivation, are shown in my project to be too important in the current research context (ECRs in STEMM) to be categorised together as "Other".

As described in Chapter 5, the most significant factor contributing to ECRs' intention to leave emerging from my model is number of years postdoctoral, indicating intention to leave increases with elapsed time. Job satisfaction has been shown to decrease with the passage of time (Chapter 4, Section 4.3.1.2) but decreases at a lesser rate than intention to

leave increases. Job satisfaction appears to be maintained by personal and organisational supports, and the love of science, (Chapter 4) while at the same time being reduced by personal and organisational barriers. Eventually the love of science is no longer sufficient. A revised framework of job satisfaction and intention to leave is illustrated below in Figure 40.

Figure 40:

Framework for Job Satisfaction and Intention to Leave



This framework shows that job satisfaction, influenced by both personal and institutional supports, declines more gradually than intention to leave which is similarly influenced by both personal and institutional factors.

While I did not aim to measure job dissatisfaction, I have certainly uncovered evidence of strong job dissatisfaction. Grinstein & Treister (2018), who found similar results in the USA, wrote that "having unhappy postdocs is not a good recipe for sustainable success of the postdoc system and for advancing top-tier scientific work" (p.1648) and suggested that there is value in policy makers, university administration, and lab managers developing a better understanding of the well-being and needs of individual postdocs. I have identified that Australian institutions, too, have a serious problem as ECRs have lower job satisfaction than both the average population (Chapter 4 Section 4.6) and other academics (Tables 23 and 24), and a strong intention to leave, demonstrated in Figure 36. This is likely to undermine their efforts to deliver the Australian Government's stated plan to advance Australia's knowledge economy (McCarthy & Wieke, 2019) or to follow the vision of the Australian Science Statement (Department of Industry, Innovation and Science, 2017) to ensure Australia's society is engaged in and enriched by science.

6.2.1.3 Identification of Factors Contributing to Intention to Leave

As discussed in Chapter 5, I have identified factors contributing to intention to leave the academic STEMM workplace. In my exploration of the interviews with eight women who had recently left academic research I also examined the processes which led these women from a range of STEMM disciplines to a decision to leave STEMM research and the reasons for the choices of the selected alternate careers.

6.2.1.4 Contribution to the Understanding of Motivation of Academics in STEMM Research

As discussed in Chapter 2, there is limited literature on the motivation of academics, and very little on the motivation of academics in STEM fields. This research project contributes to the literature about motivation of academics in research, examining further the interesting apparent oxymoron whereby scientists display relatively high levels of job satisfaction in spite of significant stress and insecurity. As discussed in Chapter 4, the participants in this project seem to be able to tolerate workplace conditions which would be unacceptable under the Australian Fair Work Act (Australian Law Reform Commission, 2009) for the love of the actual work.

6.2.1.5 Identification of a Toxic Environment for Men and for Women

It is unfortunate that I have identified in Chapter 4 and in Christian et al. (2020a) and Christian et al. (2021) evidence of toxic work environments and questionable research practices in many institutions. Hand in hand with this, also shown in Chapter 4, I have uncovered a clear need for better supervision and more mentoring for ECRs who feel they and their careers have been impacted by poor supervision.

I have also presented previously unknown information demonstrating that, in an environment where women are actively receiving support to stay in STEMM careers, it appears that men are feeling neglected, and, perhaps related, 16% of men feel unsafe at work. While I have not been able to glean further detail about this perceived lack of safety, it certainly merits further research. I found evidence that men are bullied; they, too, are impacted by gender inequity which will be discussed further in the section below.

6.2.1.6 Identification of Inequity in the STEMM Research Environment

The greatest inequity in the research environment is commonly believed to be gender inequity. The difficulties of women in the STEMM environment have been widely explored in Australia and elsewhere (see Chapter 2), and consequently, there are efforts being made by many to attract women to STEMM careers. I took the decision at the outset not to focus on the needs of women in this project, as much is already being done to address concerns about the number of women in STEMM fields in Australia, including by the Government and organisations such as Science in Australia Gender Equity (SAGE), however it is an important topic which cannot be avoided. The many recommendations made elsewhere, and, indeed, sometimes implemented in institutions with success, have included initiatives such as access to on-site flexible childcare, the facility to work from home (and be paid to do so), and assistance with attendance at meetings for parents with young children by provision of child care or travel insurance for family members (Dunstone & Williamson, 2016), but there is clearly more work to be done. Women are entering STEMM fields at the same or sometimes greater rates than men, but they leave more readily (Department of Industry, Science, Energy and Resources., 2020). This suggests the problem is more about retaining the women in science than in attracting them. Cultural change is particularly important if we are to achieve a level playing field for both men and women in the STEMM workplace.

Looking at evidence regarding inequity, discussed in detail in Chapter 4, I have been surprised to find that, generally speaking, women in STEMM are no less satisfied than their male counterparts, and there are few areas where they appear to need more care. “Gender inequity” in the literature is generally focussed on inequity for women; I wonder, in the light of these findings, whether perhaps much of the inequity discussed, which pertains to matters such as job insecurity, opportunities for promotion, work-life balance and flexible working

more typically impacts the young, both men and women, and especially parents of young families. At the same time, there is another cohort of people feeling impacted by inequity as several older ECRs have drawn attention to the fact that they, too, feel disadvantaged compared with younger ECRs (see Chapter 4, Section 4.3.1.3).

Although there is very little difference between levels of satisfaction for men and women across many measures (reported in Chapter 4) proportionally more women (16%) report feeling dissatisfied with the attitude to people of their gender than do men (10%), while, at the same time, there is a much higher percentage of women (56%) feeling supported than of men (34%). This must contribute to the suggested feeling of inequity for men; the fact that many more men (56%) than women (29%) do not hold a view one way or another suggests they might not care or might not feel impacted by gender-based support. A remark recorded in my journal during 2020, made by a mid-career researcher at a STEMM webinar provides support of the widely held view which appears in the literature: "Women represent at least 50% of the population but we are still treated as a minority group", but evidence of this does not emerge from my findings, other than for the 16% of dissatisfied women mentioned above.

It is of concern that any ECR feels impacted by harassment on the basis of power position, however the fact that more women (37%) than men (26%) report this situation (Chapter 4, Figure 17) is consistent with the views of women in STEM regarding inequity which are reported in the literature.

6.2.1.6.1 Family Caring Responsibilities

Although the focus in the literature on gender inequity tends to be on women, changes in life stage and family-related circumstances may affect both men and women ECRs. The most obvious period of non-work life which impacts ECRs is parenthood, and this can have an undue influence on career progression (Huang et al., 2020; Moss-Racusin et al., 2018).

Although the apparent differences in job satisfaction for people with and without children shown in Section 4.3.1.1.5 were found not to be statistically significant, the fact that so many women leave the academic STEM workplace at the age at which they tend to start a family as had been the case, for example, for several of the women in my interviews (Chapter 5), suggests appropriate policies need to be in place to support these people in times of change.

Unlike other careers where people can readily take time off for parental leave, then return to the workforce resuming from where they left, it is very difficult for those who take time off for child-caring responsibilities, mostly women, to maintain the requisite momentum of publishing papers and attracting funding which characterises a successful STEMM career. This particularly affects women who choose to take extended maternity leave and then find it difficult to catch up with their peers. My research has shown that there are some who simply keep working full-time writing papers and grant applications and managing their labs while technically on maternity leave (see Chapter 5). For those that do go back to work, (or have never actually left it, in spite of nominally taking leave), balancing work and family is particularly difficult and can lead to women's research profiles lagging behind either men or women without children, thus making them less competitive for the funding essential to continuing their careers in this particularly competitive environment.

The impact of caring responsibilities has been highlighted during the COVID-19 pandemic. Several authors (Buckee et al., 2020; Johnston, 2020) have already documented the impact on women's research, probably as a consequence of the need to care for children unable to attend school. Myers et al. (2020) showed that women scientists and particularly scientists with young children reported that time available for research had been substantially affected; it is important to note that there is currently no way of evaluating this as career

interruption so people who have been caring for children during COVID-19, whether men or women, are at a disadvantage to their child-free peers.

There is significant attrition of women in the STEMM workforce when they decide to start a family (Huang et al., 2020; Moss-Racusin et al., 2018), however it is not only the responsibility for caring for children which merits consideration. Those scientists who must care for elderly parents or sick partners also find the expectations of long hours especially difficult to manage (Smith, 2020) and I have found evidence of the need to care for members of the family other than children (Chapter 4). In addition to those who care for children, responses to Q15 Are you responsible for the care of any adult due to their ill-health, age or disability? showed many people have the care of chronically ill partners and parents including care for parents both in Australia and overseas. While this situation is, of course, not the case only for people working in science, it is extra-difficult for people who are already coping with job insecurity and workplace stress.

The caring for other family members was highlighted in my research:

> responsible for 2 adults: mother and father. One with Alzheimer's and the other with high level end of life care (Survey respondent 72)

> My dad has parkinsons [sic] and mum has a brain tumour, both need lots of support medical appointments etc (Survey respondent 125)

> I am responsible for the remote care of my parents, who live overseas, I am an only child of divorced parents. Although my father is in a nursing home, I am in charge of overseeing the payments to the nursing home, visits to the doctor and all the issues that an ill elderly person has. Additionally, I support my mother economically as she doesn't have a pension. (Survey respondent 157)

> Parter [sic] is cognitively and physically disabled (Survey respondent 692)

This Section 6.2.1 has explored aspects of the workplace from the perspective of ECRs in STEMM. Section 6.2.2, which follows, discusses identification of a need for more training and career planning.

6.2.2 Findings: Identification of a Need for More Training and Career Planning

My research has identified low uptake of generic management training for the sorts of skills which relate to all workplaces and lack of preparation for, or knowledge of, other careers in science outside academia. These matters are reviewed on the following pages.

6.2.2.1 Background about Professional Development for ECRs

6.2.2.1.1 Definition of Professional Development

I define professional development for ECRs in STEM as covering a range of activities including training, career planning, mentoring and to a lesser extent, elements of personal development. I suggest all these can contribute to the growth of the scientist and their career. Professional development could interchangeably be referred to as "researcher development", which is a term becoming used for development of the research capabilities of individuals more frequently (Browning et al., 2014; Sutherland, 2018c). The broad definition I propose is consistent with the principle within the "UK Concordat to Support the Career Development of Researchers" which states "researchers must be equipped and supported to be adaptable and flexible in an increasingly diverse global research environment and employment market. This Principle recognises the importance of continuous professional and career development, particularly as researchers pursue a wide range of careers." (Vitae, 2019, p.6). The Concordat defines career development as "the ongoing process of researchers taking responsibility for, and managing, their careers, through seeking professional advice and working towards set goals.".

When examining researcher development, as discussed in Chapter 2, previous researchers have focussed more fully on the doctoral environment than on the workplace environment for early career researchers. There are few studies on the supports and barriers to researcher development for early-career researchers in STEMM, and none I am aware of in Australia. In findings which will be described in more detail below, I have identified gaps in uptake of training by ECRs and, at the same time, have identified a need for the skills which that training could provide. I have discovered ECRs involve themselves little in career planning and have demonstrated there is an almost complete absence of career advice available to ECRs who wish to consider transitioning outside of academic research if, indeed, they will consider such a transition at all.

As has been described in earlier chapters, research into working conditions for ECRs in countries including UK, USA, Canada and Europe has shown that, as for Australia, job insecurity and uncertainty about future employment are significant sources of stress among the researchers (Boman, 2017; [Editor, Nature], 2018b; Helbing et al., 1998; Waaijer et al., 2017). The literature has also shown that ECRs receive insufficient, (if any), counselling for career planning (Åkerlind, 2005; Helbing et al., 1998; Vitae, 2012); and that ECRs are often unaware of, or unwilling to consider, careers outside of academia (Jahn, 2018; Woolston, 2018). Some have hypothesised that ECRs believe their institutions place low value on them (Bogle et al., 2018; Helbing et al., 1998) and, in a view I share, that perhaps ECRs are valued by their employers more for their immediate research output than as a future resource (Bogle et al., 2018).

Researcher development is an important but largely underexplored topic, yet it has implications for our future national capacity for knowledge generation and leadership in higher education (Gibbs et al., 2015; McAlpine & Emmioğlu, 2015; Robbins & LePeau,

2018). Thanks to the Australian Government's efforts to increase investment in STEM education, there are more and more PhD students in STEM fields (Department of Education, Australian Government, 2019; Department of Industry, Innovation and Science, 2017; National Health and Medical Research Council, 2016; Norton et al., 2018), however if the Government's stated wish to build a STEM-powered economy (Baranyi et al., 2016; Department of Industry Innovation and Science, 2018; Shine et al., 2019) is to become a reality, institutions need to establish ways to encourage the development of the next generation of the STEM researchers in Australia. Investing in the professional development of our ECRs may help them towards long-term success and encourage them to stay in science careers (Bogle et al., 2018; Christian, 2018; Department of Industry Innovation and Science, 2018; Robbins & LePeau, 2018; Tregoning & McDermott, 2020). Many of those investigating the workplace experiences for researchers believe institutions should offer training for ECRs in generic management skills in addition to core scientific skills, as well as providing career planning to help prepare them for the variety of opportunities which might lie ahead (Bogle, 2018; Robbins & LePeau, 2018; Sutherland, 2018c).

Writing in the NatureJobs blog, Bogle (2018) recommends ECRs should not be just "paper-writing machines" but should be nurtured as future independent scientists who are in need of, and deserve, professional development. He recommends the postdoctoral period should be a time where scientists are encouraged to develop a deeper and more sophisticated set of skills than those acquired during the doctorate and that ECRs need time to consider their development needs, and to spend time developing further skills. Bogle especially notes that this should all take place during a working week that offers work/life balance. He warns that the constant pressure to produce more research prevents ECRs from finding the necessary time to think about their personal development or to spend time with friends or family and

warns it is no coincidence that so many postdocs burn out. Others support his views ([Editor, Nature], 2018a, 2018b; Herbert et al., 2014; Powell, 2018).

Reviewing the success of the Concordat in the UK, Bogle et al., 2018 report there has been considerable improvement in researcher access to training resources and that many employers do recognise the powerful skills that researchers develop which can be used in a wide range of roles outside research, although they do say further progress is required. Other organisations have taken similar steps in recent years, including the Max Planck Society in Europe which has developed guidelines for training its ECRs (Jahn, 2018). The National Academies of Sciences, Engineering and Medicine in the USA have also published recommendations for the support of academic researchers in the biomedical sciences (National Academies of Sciences, 2018).

6.2.2.2 Professional Development for ECRs in Australia

Until now there has been only limited investigation of the existence of training, or into the effectiveness and usefulness of professional development opportunities available to ECRs in Australia; nor has there been research into the extent to which these opportunities are taken up by their intended audience. “Research into researchers” is bringing with it awareness of the benefits of professional development and career planning (Gonzalez et al., 2019; Manathunga et al., 2007) but there is still little evidence of further investment in these expensively trained young scientists once they reach the postdoctoral environment.

Åkerlind (2005) provided some information on Australian ECRs in STEM. Though now fifteen years old, her paper highlighted key structural and cultural issues associated with training for postdoctoral researchers and he drew the conclusion that both training and career support for ECRs were unstructured and ad hoc in nature. Aiming to fill this gap, I have collected information about the training ECRs had done, or would like to have done, and

whether the training on offer at their workplaces met their needs. I also investigated whether, in their insecure work environment, ECRs placed importance on planning for their future careers, whether inside or outside academia, and whether the career planning support they might have required was available.

I have extended the limited previous work by investigating the views of the ECRs themselves about their professional development. In the following sections I will discuss the views of ECRs about their training and then about their career planning, and the support – or lack of support - for this professional development provided by their institutions. I also discuss the views of ECRs regarding careers outside academia, which I refer to as "alternate careers". My on-line survey results show professional development, in forms of both training and career planning, is often neglected by Australian ECRs in STEM fields, and by their supervisors and institutions.

I hypothesise that their (necessary) focus on publishing and applying for funding leads ECRs, and those who supervise them, to neglect their professional development, whether it be training, overall career development or career planning. The ECRs fail to focus on long term career goals and, instead, "live in the moment". The focus on grant writing and papers is illustrated in the quotes below:

> Too much grant writing to secure funds in order to extend my current postdoctoral contract, not enough time to do the actual work (Survey respondent 350)

> ECRs are encouraged to apply for grants and establish their careers, yet with such a small amount of funding available for medical research in Australia, you put in a lot of time, effort etc into writing these grants only to be knocked back time and time again (Survey respondent 234)

6.2.2.3 Findings Relating to Training

I explored participation in training by the nature of the training and the likelihood of uptake. This will be discussed in detail below.

6.2.2.3.1 Research and Academic Skills Training

Responses to questions about their participation in training indicate that ECRs are more likely to attend training in the topics I have identified as "research and academic skills", (ethical research conduct, grant writing, interdisciplinary research, intellectual property, knowledge exchange, tips for your publishing, research impact, research skills and techniques, teaching or lecturing), however, only about half the respondents have completed courses on the skills important for a successful research career in STEM, including grant writing (53%) and publishing (49%). This low uptake is consistent with previously published research (Gascoigne, 2012; Laudel & Gläser, 2008; McKeon et al., 2013).

6.2.2.3.2 Generic Skills Training

Completion of training for topics I have defined as "generic skills" (budget management, career management, collaboration and teamworking, communication and dissemination, equity and diversity, personal effectiveness, project management, mentoring and being mentored, public engagement, supervision of doctoral/masters students) is less common, suggesting these are of lower importance to the ECRs. Uptake of project management training (24%) and budget management training (10%) topics, which are valuable for a successful scientific research career, (Bogle et al., 2018; Christian, 2018) is notably low. It is interesting to note that a recent study of European and Israeli PhD students showed that 95% had never received project management training and recommended it should be included as part of their postgraduate studies (Katz, 2016). Rybarczyk et al. (2011), too,

support the value of generic training having found that a postdoctoral training program that included training in ethics, managing budget, grant writing and use of technology greatly assisted the career progression of participants who also successfully supervised more students, were more involved in teaching and took up additional professional development opportunities. The value of professional development for postdoctoral staff has been supported by others (Bhakta & Boeren, 2016; Eigi et al., 2018; McAlpine et al., 2016).

In recent work which explored the benefits of professional development for postdoctoral staff employed at a university in New Zealand, Tate (2020) concluded New Zealand universities should provide focussed resources for ECRs in relation to research project management and development of mentoring circles which would ultimately benefit both he ECRs and the university administrative staff who currently provide significant resources to assist ECRs who have not received sufficient training.

6.2.2.3.3 Training ECRs "Would Like to have Taken"

There were two reasons ECRs reported training they "would like to have taken". Firstly, many respondents reported they would like to receive training which they say is not available at their workplace. The highest responses with this answer are for training in topics which I have categorised as generic skills training, namely budget management, project management and career management.

Secondly, between 13% and 30% of respondents reported they "would like to have taken" training on a number of topics, but they feel "they have no time". Overall, there are slightly more ECRs who answered "they would like to do this training but have no time" for generic skills training topics than for topics in research and academic skills training. My findings, confirmed by personal observations, suggest the likely reason for the "lack of time" given by these Australian ECRs for not undertaking training is that their workplace does not

promote its value; it seems there is no incentive or encouragement for ECRs to focus on their personal or career development when there is overwhelming pressure for results, papers and successful grant applications. Without encouragement to look after their personal goals, the ECRs have no capacity to even consider additional commitments outside this core need.

6.2.2.4 Findings Related to Supervision

As reported in Chapter 4, 60% of respondents in my on-line survey reported that they or their career had been impacted by poor supervision. This is completely unacceptable; the well-being of the ECRs is very much dependent on their supervisors (Lashuel, 2020). The Australian Code of Responsible Research Practice requires institutions to support a culture of responsible research conduct and states that researchers must provide guidance and mentorship on responsible research conduct to other researchers or research trainees under their supervision and promote their education and training. Together, these requirements mean that supervisors must provide adequate supervision. While it is understood that senior researchers are often, perhaps usually, under extreme pressure themselves (Lashuel, 2020), this does not provide the institutions with an excuse to fail in their duty of ensuring supervisors of research trainees have the appropriate skills, qualifications and resources to carry out their duty. The resource which is likely to be missing is time; this shortage is likely to come back to a culture impacted by job insecurity and too much pressure to attract funding which has been demonstrated again and again throughout this thesis.

It has been recommended that research organisations provide structure to integrate ECRs into the institutional work environments which will bring about regular interaction with others, whether or not these postdocs otherwise have autonomy and independence in their research direction. Following the example of the National Science Foundation in the USA

(Davis, 2009) and Miller & Feldman (2015) also recommend processes such as the ECR and supervisor jointly developing a research plan at the outset.

6.2.2.5 Findings Related to Mentoring

Mentoring is increasingly recognised as a critical element in supporting successful careers in academic research in scientific disciplines, particularly for trainees and early career investigators from underrepresented backgrounds. There has been shown to be great benefit to ECRs from mentoring from independent advisors which has been reported to be nurturing and focussed on the needs of the mentee on topics including workplace troubles, career advice and perspectives on methodology (Briggs & Pehrsson, 2008; Christian & Scott, 2019).

Surprisingly, high numbers of ECRs reported not having received any form of mentoring over the course of their academic career, and many do not take part in a formal mentoring scheme as a mentee, yet "Having a good mentor early in one's career can mean the difference between success and failure in any career." (Lee, 2007 p791).

Effective mentoring has been found to contribute more to a PhD student's overall satisfaction with their PhD program than any other factor (Abbott, 2017), but mentoring should continue beyond the PhD and into the postdoctoral stage (Christian & Scott, 2019; Friesenhahn & Beaudry, 2014). Established researchers consistently hold the view that their mentors provided them with the best form of support during their research career. They give their mentors credit for having helped them establish good and effective networks, for identifying opportunities for funding or publishing, and for assistance with goal setting. They are consistently grateful for the clear-eyed views that helped them sort out issues with their work. In short, their mentors helped them push their career along.

A report released by the Global Young Academy in 2014 (Friesenhahn & Beaudry, 2014) showed that young scientists around the world highlighted the importance of having a circle of people who could advise them on their career decisions. Their data indicated that 63% of respondents said senior colleagues were their most important advisers in that respect, 39% mentioned mentors. Supervisors, mentors, and senior peers were particularly important for "the encouragement and reassurance they provide in addition to giving feedback, exchanging ideas, discussing results, and encouraging young scholars to accept new challenges" (Friesenhahn & Beaudry, 2014, p. 28). The report found that, all over the world, trusting relationships with senior colleagues were seen as the most important source of support for career development (Pain, 2014). Further, in developing countries those friendships helped in securing the most attractive jobs, such as professorships, within their national higher education system, researchers in developed countries benefited from the global network of their senior friends giving them access to the most respected research groups, labs and universities, allowing them to present their work at the most prestigious conferences and publish in the most important books and journals.

In spite of these recommendations, and many others along the same lines, a recent study in New Zealand showed that 34% of early career academics report not having had any form of mentoring over the course of their academic career, and only 26% have engaged in a formal mentoring scheme as a mentee (Sutherland, 2018a).

In recent years there have been special efforts made to offer mentoring for women in many countries. The Athena SWAN Charter (Ovseiko et al., 2017) is an evaluation and accreditation program that has been running for over a decade in the UK, with tremendous success in enhancing gender equity for science, technology, engineering, mathematics and medicine (STEMM). It was introduced in Australia as Science in Australia Equity (SAGE) in

2015 (Science in Australia Gender Equity, 2015, 2018). In Australia, we also have the highly regarded Franklin Women Mentoring Program (Franklin Women Mentoring Program, n.d.), instigated by a community of women working in health and medical research-related careers. Although there are certainly efforts made for establishing mentoring programs within some Australian institutions (for example, Monash University, Walter and Eliza Hall Institute of Medical Research and University of Sydney) they tend to be focused on final year undergraduate and PhD students. I have not been able to find evidence of a wider or consistent approach to provision of mentoring for early career researchers in my project data.

6.2.2.6 Findings Relating to Career Planning

I also investigated the ECRs' approaches to planning their future careers. When they were asked to consider their views at the time they completed their highest degree (Q55 "In general, upon the completion of your highest degree, do you agree you were confident in your career prospects?"), only 39% agreed they were confident, then, in their career prospects. Now, in the workforce, only 35% of these ECRs reported they have developed a clear career plan, in spite of the fact that job insecurity is clearly their major challenge. My results showed that the majority of the respondents are on short term contracts; 81% were on fixed term contracts. Of these, 65% were on contracts of one to three years, and 17% on contracts of less than one year. When asked about their future (Q64 "Where do you expect to be in five years' time?") only 54% replied that they expected to be in a similar role or higher role in same or similar workplace in Australia in 5 years' time although 75% would like this to be the case.

Responses to Q56 "whom do you rely on for career advice?" show ECRs rely almost entirely on people within their usual research environment for career advice. Their current supervisor is the most often their advisor (41%). Some rely on a previous supervisor (15%) or their doctoral supervisor (12%) or else a senior person from their current environment (13%),

while 14% have no-one they rely on for career advice. If they have a mentor (60% of respondents), the mentors are often a source of career advice (59% of those who have a mentor).

The respondents reported their use of a range of channels to help with career advancement, including attendance at career seminars and workshops (72%) and at networking events (68%). In response to Q59 “Which, if any, of the following activities have you done to advance your career?” over half (59%) selected “developed a social media profile”; only 22% of respondents say they have developed an individualised development plan or discussed their future career with a graduate adviser (18%) or careers counsellor (4%). In answer to Q57 “How do you learn about career opportunities that are beyond academia?”, only 15% reported their institutions provide relevant workshops and resources.

It has been shown that prospective PhD students in STEMM fields are not thinking strategically about what they really want to do in their career or what they are best suited for (Gould, 2015); nor, it seems, do they enter research as an ECR having properly considered the insecurity of the path they have chosen. Historically, the universities have not provided information about career paths and many are overly optimistic about their chances in academia. This may have changed for some following the recommendations of the ACOLA Review (McGagh et al., 2016), which included provision of information about the likely career outcomes for postgraduates, although there is little apparent impact from these recommendations revealed in the literature. In Gould’s (2015) feature article on PhD students in USA, 78% of respondents said that they were "likely" or "very likely" to follow an academic career, and 51% thought that they would land some type of permanent job in one to three years (p.23). In reality, only about 26% of PhD students in the United States move into tenured or tenure-track positions and getting there can take much longer than this (Gould

(2015). There are key gaps relating to the range of job opportunities, earnings, time spent as a postdoc and long-term career trajectories. Although I did not ask the same questions, the qualitative data in my on-line survey results indicate that the same misconceptions are present in Australia. Nearly all the ECRs said that they want to stay in a research career. When asked in Q60 to "ignore practical constraints and consider an ideal world", 84% said that they would like to remain in research. This optimism is inconsistent with their concerns about job insecurity. As shown in the earlier chapters job insecurity and lack of funding are prime concerns, a view supported by the answers to Q33 "If there was one factor you could change that would make a major difference to your levels of job satisfaction what would it be?", where 51% nominated job insecurity as the one thing they would change.

My results indicate that the only action many ECRs take about planning their career is to worry, and to talk to people in similar circumstances. An overwhelming 84% of participants responded that a research career was their ideal for the medium-to-long-term yet, in an apparent contradiction, as shown in Chapter 5, at the same time 80% of ECRs answered they had considered a serious career change in the past five years. This is almost certainly a reflection of their job insecurity. Focussed as they are on staying in academic research in any way they can, it appears they are simply aiming for the next job, a view discussed by McAlpine et al. (2016). Most do not have a career plan either for advancing their current career or developing a career elsewhere. It seems ECRs in STEMM are focussed on a career in research, apparently at almost at any cost, and rely on people within the immediate environment they want to remain in, or family members, for career advice.

6.2.2.7 Findings Relating to Planning for Alternate Careers

As has been discussed earlier and in Chapter 5, there is a reluctance amongst ECRs in STEMM fields to consider alternate careers. In the light of the insecure environment, I was

interested to find out whether ECRs had considered careers outside academic research. Almost a third of the respondents reported that they were only interested in working in academia and so do not look elsewhere; only 2% had ever had a consultation with a careers counsellor at their institution and 9% had discussed their future with a graduate careers advisor. In answer to Q58, "Does your institute have career advisory services for science ECRs?", 41% of respondents said that they did not know, 26% reported there was no such service and 13% said that career services are available, but they have not made use of them. When asked in Q57 "How do you learn about career opportunities that are beyond academia?", the most common responses indicated they had searched the internet, selecting either social media avenues, jobs boards or other online services. About a quarter of the respondents selected science publications, scientific conferences and people in their departments as key sources for information about career opportunities.

6.2.3 Tangential Findings: The Detrimental Influence of "Gatekeepers" on Research

As discussed in Chapter 3, the HREC approved my proposed research with a condition that prior to extending an invitation to any staff member, at any institution, to participate in the research, I should "submit the external organisation's approval/permission letters" to the HREC. This requirement had significant consequences for recruitment which are addressed in Chapter 3 and in Christian et al. (2019), within that chapter.

As previously shown, the processes I had to take in order to gain permission to survey university employees led to my receiving approvals from 23 of a potential 37 universities (62%) and eight of a possible 42 medical research institutes (19%, although 100% of institutes which were directly approached), and no refusals. Invitations to take part in the on-line survey were ultimately distributed to ECRs by a variety of means, both by email from inside the institutions and externally, and by social media, resulting in the recruitment of 658 eligible

participants from across Australia. As described in Chapter 3, these respondents were drawn from at least 31 institutions. In order to protect their anonymity, there was no additional tracking data collected for respondents, so the only way to tell where they were from was if they chose to answer the optional question about the name of their institution.

The spread of participants demonstrates this requirement for gatekeeper approval impacted the sample in a manner not dissimilar to that demonstrated by Kearney et al., (1983). They showed the need for written parental consent for research on a student population was estimated to have reduced the sample size by half and, simultaneously introduced sample bias. Although it cannot be shown which of the many invitation avenues motivated any individual participant to take action, as 78% of my research participants who identified their institution came from the "approved" universities there was clearly a strong influence on the makeup of the ultimate cohort. I expect this was from the effective reach of email communication from within the universities. There is no reason to believe there would have been more or less influence of social media or communication from the umbrella groups on the potential participants whether they worked in "approved" institutions or not.

I endorse the view of Kearney et al. (1983) that there is a need to further investigate the consequences of explicit consent procedures such as those required of me by the HREC. Singh & Wassenaar (2016) show that in many cases gatekeepers play an essential and undervalued role in the generation of good research data. I acknowledge those benefits while at the same time supporting the view of many other social scientists that the gatekeeper approval process can be "tedious, time-consuming and obstructionist" (Singh & Wassenaar, 2016, p.42), as it certainly was in this case. While gatekeepers can facilitate access to participants, they can also bar the way, and ultimately my negotiation with those in power (or those who were gatekeepers for those in power) became a critical skill within this process, in a way similarly recorded by Walker & Read, (2011).

The variety of means by which the umbrella bodies reached their dispersed members, and the very nature of social media and its promotion of sharing resulted in a very broad distribution of the on-line survey invitation. As I received responses from people working in at least 29 institutions which had not given approval as a consequence of (ethically-approved) promotion of the on-line survey via social media, third parties and the snowball effect (Atkinson & Flint, 2001), this led me to question whether the approval process was actually redundant.

At the same time, the "approval via gatekeeper" process, even when seeking approval was successful, provided a barrier to distribution of the invitation. In several instances the approver undertook to distribute the invitation email, or have it distributed, without providing me with either any further information or the name and contact details of the person who would be given this task. As there was a significant imbalance of power between me, a PhD researcher, and this person in a position of high authority, it was usually impossible to follow up, and check whether indeed the task had been carried out; I was not comfortable to trouble these people by re-contacting them to make sure they had fulfilled my request. As there are no known responses from two universities where approval had been granted, and very low numbers from some others, I suspect that the invitation was never actually distributed.

While the many pathways to recruitment cannot be identified exactly, there were certainly spikes in enrolment following some specific actions, such as the release of the EMCR Forum newsletter or efforts to promote participation on social media. It is not possible to track these spikes in the on-line survey data as, in order to ensure anonymity, time and date of participation were not recorded. Nevertheless, I maintained a record of the overall numbers of responses and could readily see increases following to external activity.

As described in Chapter 3, the most efficient way to distribute the invitation (post approval) was via the research offices. Key people in these offices were able to identify and

contact the target audience with minimal effort and no coercion, and their efforts achieved excellent reach. As a consequence, the participant cohort is strongly skewed to those institutions which gave approval (estimated at 78%).

I conclude that the need for gatekeeper approval from institutions, prior to distributing invitations to their staff, to participate in this research survey led to a bias in the cohort of survey participants to the approved institutions. On the other hand, failure to receive approval prevented participation from the people who worked in those institutions from taking part, as they remained unaware of the opportunity.

6.2.3.1 Questioning the Ethical Need for Gatekeeper Approval

I question whether the receipt of institutional approval mitigated any perceived risk from the conduct of this project – and indeed, whether this approval was necessary at all. The project had received ethics approval which included approval for a variety of methods of extending the invitation to on-line survey participants including sending the invitation "into the unknown" via social media, and approval of distribution of the invitation to third parties. At the same time, the research itself did not provide a risk to the institutions but rather could ultimately bring them the benefit of clearer understanding of the views of a sector of their staff.

Research in Australia is governed by the Australian Code for Responsible Conduct of Research (Australian Research Council & Universities Australia, 2018) and the National Statement on Ethics (National Health and Medical Research Council, 2018). This project was compliant with the requirements of both without the stipulation imposed by the HREC. The additional requirement within the ethics approval for a further approval from each institution was a barrier to this research. I believe that individuals within the ECR population that I was attempting to sample should have been permitted to make up their own minds as to whether they might participate or not, as they do not fall into the type of special category suggested in

the National Statement so there was no need to have this request filtered by their employer. Instead, I had to rely on either the co-operation of "gatekeepers" in contacting potential participants on my behalf and/or on advertising my research and waiting for individuals to come forward and volunteer to take part. A similarly inefficient experience has been described by Miller & Boulton (2007).

As was described in Christian et al. (2019) (see Chapter 3, Section 3.8.2) although the request for approval was a consequence of an ethics obligation, it is possible the people required to give that approval may not be responding to the request with the requirements of the National Statement in mind, but in their capacity as employers, or as gatekeepers for their staff. I support the view of Walker & Read (2011) that while gatekeepers provide an essential service in protecting a vulnerable population, they can also prevent potential able participants from speaking for themselves or exercising agency in their own right.

Durham University provides advice on "Research involving a Gatekeeper" on its website (https://www.dur.ac.uk) where they point out that requesting gatekeeper approval from an employer may be required, but there are times when this is neither possible nor desirable. They warn researchers to be wary of requests from an employer to see or filter the responses or to receive special access to data collected.

The concurrent, legitimate methods available for recruitment of people to the study by other means makes the need for institutional approval even more redundant as they permitted participants employed by the universities which had not given approval to self-select. Had approval been denied by any institution, this denial could not have prevented participation via other avenues.

6.2.4 Tangential Findings: The Advantages for Insiders Conducting Research within Universities

As has been shown above and in Chapter 3, achieving the gatekeeper approval from universities was problematic and proved to be a barrier to the research. There were two parts to this problem: not only was it hard to identify who the gatekeeper would be, i.e. who to ask, but it was also difficult to identify the process which would be required to obtain approval in each university; they were all different.

The requirement for seeking approval on behalf of a very large organisation such as a university required that approval to be provided by someone holding a position of high authority; by definition, the person was very busy with complex responsibilities. I found it was often difficult, sometimes impossible, to reach the person who would be responsible for making the ultimate decision. At the same time, without that permission, the research could not proceed as it was essential to comply with the request of the HREC.

Gatekeepers who control access to research participants, or gatekeepers to those gatekeepers, are in a powerful position. It is perhaps obvious that the starting point for finding a particular university staff member or name of person in a specific position would be the university website. In approaching this task, I found that a search of the website could usually identify the organisation's structure, (although sometimes after a protracted hunt), allowing me to select or identify the most appropriate recipient for my letter and, sometimes, a matching email address. Very often, I could only find generic email addresses for either the position or assistant to the incumbent (gatekeeper to the gatekeeper), and it was more difficult to solicit responses from the mail sent to these anonymous addresses than from direct requests to an individual's email address. My long experience working with people in academia had allowed me to develop knowledge of ways to dig deeper and find the direct

email addresses of many recipients who would otherwise be "hidden". This was a task for which my insider knowledge was very useful.

It was always important not to be seen to be overly pushy and to avoid coercion, while, at the same time, I needed to try to make contact on the assumption that the request may have been genuinely overlooked or had not reached the intended recipient. My thorough understanding of how the university "system" operates was critical to working out the next step, and vital to the (relatively) successful outcome of achieving approval from 62% of universities.

As explained in Chapter 1, I have been working in research management, mostly in medical research, for over 30 years. Much of my work has included provision of research support for ECRs in almost every university and many medical research institutes across Australia. I believe that this experience and knowledge was essential in my obtaining sufficient approvals and ultimately managing to recruit a large enough sample for the project. It makes me question whether an "outsider" would have managed to surmount the barriers and whether surveying this population is effectively restricted to those from "inside" academia.

6.2.5 Tangential Findings: Identification of a Need for Universities to Improve Communication with Outsiders

As an unexpected by-product of the research method, (not quite a "finding", nor a recommendation, but an observation of a matter requiring attention), I have also identified a need for universities to improve their communication with "outsiders", (i.e. those not employed in or a student of the university) by maintaining up to date information on their websites and by providing information about processes required to permit outsiders to conduct research inside their institutions. I was not able to find even one university which had published advice for appropriate contact for external researchers available on its website.

I conducted a Google search for "approval to conduct a survey" and sometimes found evidence of survey approval processes required for people within the university who were wishing to conducting surveys of students or, sometimes, staff members, but every time the full information was only available on the intranet.

It should be noted that approval processes for Adelaide and Curtin Universities to which I was directed (reported in Chapter 3) were also clearly designed for internal staff. I expect the true purpose for the processes at each of these two universities was a requirement leading to ethics approval for a planned internal research project.

6.2.6 Summary of Findings

In summary my project has achieved my aim of contributing to the existing body of literature on the STEMM workplace for early-career researchers in Australia, particularly on factors which contribute to the job satisfaction of those researchers and their intention to stay in, or leave, the academic research environment. Somewhat unexpectedly, I have also contributed to the literature about consequences of the need to seek approval to conduct research from the institutions (as opposed to the participants), and on the influence of "gatekeepers" on the outcomes of the approval processes required and found that some aspects of outward-facing communication from universities could be improved.

My study confirms some of the work of others in the field (in Australia and in other countries) and demonstrates a worsening situation in Australia. It is the first study to explore the overall research work environment for ECRs in STEMM and the personal consequences to the researchers of the debilitating but prevalent job insecurity. I have also contributed new understanding of where ECRs might work when they leave academic STEMM and the decision processes they make with respect to their leaving. Ultimately, my findings have confirmed that the circumstances I had identified through my experience working in medical

research were replicated elsewhere; these findings indicate conditions in many work environments are significantly worse than I had expected.

6.3: Recommendations for Identifying and Addressing Some of the Challenges for ECRs

The prime recommendation of this project, contained in Recommendations Section One, is that the universities and research institutions, perhaps in conjunction with the Australian Government, must address this situation, and thus must respond to both this and previous calls for change to job insecurity for people in academic research in STEMM (Bell & Yates, 2015; Hardy et al., 2016; Phillips & Meacham, 2015).

In the following sections I address seven other sets of recommendations for changes in the workplace which could enhance job satisfaction for ECRs and contribute to lessening their motivation to leave academic research in STEMM disciplines in Australia.

6.3.1 Recommendations: Act on the Previous Reports!

In some respects, it is difficult to make new recommendations as there have been so many Australian Government reports written over the past twenty-five years (identified in the literature review in Chapter 2) which clearly recognise there is a problem for ECRs in STEMM. These reports have called for action in many ways; it is extremely frustrating that, again and again, their recommendations have not been acted on; in fact, the situation has been permitted to deteriorate. As far back as 1996, Bazeley et al. (1996) identified a significant gap in basic research funding for those who are 'mid-life' (p129). Bazeley et al. (1996) defined these people in “mid-life” as the people I define as in the latter half of the ECR demographic –those I have established as most likely to leave the research environment. Bazeley et al. (1996) also point out it is generally accepted that the most creative period of an investigator's

professional career is at the beginning of his or her independent research, and that while ideas generated then often do not come to fruition until many years have passed, support during the early years is crucial. That support is essential to eventual development of these new researchers who must provide the intellectual leadership in the future (NBEET 1995 Review of Grants Outcomes 16, Inorganic Chemistry, p.31 from Bazeley et al. (1996)), yet this is the time we are letting many of them go, just when they are reaching their potential. At this point, each departing researcher is the product of 10 to 15 years of university education and training, representing an investment (mostly by the Government) of at least $500,000 (Shaw & Chew, 2020). While those who manage to stay might well be the "stars", they may also be those with luck on their side (McAlpine et al., 2016; Tregoning & McDermott, 2020). Whoever they are, they have been highly trained at significant cost and they merit receiving further opportunity.

Edwards & Smith (2008) warned the Australian Government the lack of career trajectory and limited tenured opportunities for higher degree graduates in the mathematics and science fields are somewhat in contrast to the demographic reality of an aging workforce facing academia over the coming years. They noted that while there had been widespread acknowledgement of these issues, there had been little change in funding or recruitment strategies to deal with impending problems. Edwards and Smith (2008) recommended efforts be made to retain young scientists and mathematicians in universities as the key to ensuring that retirements in the academic workforce do not result in severe workforce shortages, however the number of short and fixed-term contracts for academics in the natural and physical sciences, which was growing then, is certainly still growing now.

In 2012 Gascoigne (2012) provided recommendations which would be easy and relatively inexpensive to implement; yet again, there appears to have been little or very limited progress:

> the system can be improved at little or no cost: bolstering mentoring programs, adding flexibility to national funding programs, creating a web-based communication system to provide career information; and screening funding applications to weed out (at an early stage) proposals with a low chance of success. They say the cost of writing proposals is too high given the limited chance of success in a system they regard as overly competitive." (Gascoigne 2012, p.68)

Along with many others who have written about this situation before, I recommend that institutions must do whatever they can to urgently address the issue of job insecurity which has so clearly emerged as the most important factor contributing to lack of job satisfaction and to intention to leave.

Institutions must also work to address the toxic workplace cultures and stamp out the questionable research practices which appear to exist in many institutions, and which are described in Chapter 4. To do this, institutions must offer leadership training, so both present and future leaders are empowered to address these inappropriate practices and ensure proper supervision and mentoring are provided for ECRs. Last, as discussed above, institutions should offer more, and more suitable, professional development opportunities, particularly generic management training, career planning and career advice for careers within and outside academia. These further recommendations which could improve the situation for ECRs in STEMM are expanded upon below in Recommendations 6.3.2 to 6.3.5.

6.3.2 Recommendations: Improve Institutional Culture

- Provide leadership training
- Improve Supervision and Extend Mentoring
- Address Questionable Research Practices
- Address Sexual Harassment
- Provide Orientation for New ECRs

I have found substantial evidence of poor workplace culture and unacceptable workplace practices, as demonstrated in Chapters 4 and 5. It appears that ECRs put up with these unacceptable workplace conditions because they love their actual work, and the institutions are able to ignore bullying and harassment and other questionable and unsafe work practices. Like Smith (2020) who believes this would be seen as unacceptable exploitation in other workplaces, I question whether this culture would be permitted to continue in other jobs. It is clear that individual principal investigators often hold disproportionate power over their research teams which makes it difficult for the team members to contend with ingrained bad practices.

I hypothesise that Australian institutions take advantage of the passion for science reported in Chapter 5 and treat the ECRs as an expendable resource, failing to address the difficulties found in the workplace. There are many more PhD graduates "waiting in the wings" so the intention to leave which comes as a result of stressful working conditions is unfortunately not of sufficient consequence to the institutions to cause them to act on it.

Although not a topic directly addressed in this project, it has been shown that the senior researchers, too, are impacted by stress and over-work (Lashuel, 2020) and this must necessarily have an influence on the workplace culture. This stress and over-work do not provide senior researchers with an excuse but could be a reason for poor supervision and thus present another aspect of the research workplace which needs urgent attention. Lashuel (2020)

points out there is a scarcity of data on the prevalence of stress, anxiety and mental-health problems among professors and that it is very rare for universities to conduct surveys to assess satisfaction, mental health and well-being of their senior academic staff. He suggests it is almost as if dealing with stress and anxiety, and an ability to withstand mental-health challenges on your own, are key criteria for whether someone is fit for a job in academia. These observations are certainly supported by my findings. I suggest, as recommended by Lashuel, there would be benefit in holding open, community-wide discussions on work-related stress and mental-health of all academic staff members working in research in STEM disciplines.

University leaders should pause and consider the costs of "business as usual" and the impact of their policies, actions and leadership style on their staff, and particularly their early-career staff. My data provides a clear picture of a distressed workforce on the verge of departure. It strongly supports the views of Smith (2020) who suggests once individuals are affected by poor mental health, their inability to keep up with the stresses of long days, an overload of work and often unreachable targets, together with a lack of support integrated into the culture, often means that these individuals are eventually lost to science.

I note that in the face of similar findings in their recent report (Wellcome Trust, 2020), Wellcome Trust have established a website on which researchers can submit suggestions for improving research culture (Gewin, 2020), an easy and cost-effective first step which could be duplicated by all institutions.

6.3.2.1 Provide Leadership Training

It is remarkable that although management of research teams is nominally delegated to senior scientists, most receive little - if any - training. (Austin, 2007; Smith, 2020; Van Noorden, 2018). Unfortunately, it is common for senior scientists to complain bitterly about

aspects of the job such as administration and meetings that they see as "taking them away" from their own science. My personal observation and anecdotal evidence recorded in my journals indicates they often view training courses in a similar way, and refuse to attend them, even if such courses could potentially enhance their ability to manage a diverse research team. Instead, they claim to know best what is required for success in their field, and hence how to train the next generation (Smith, 2020). Supporting this view, a 2018 Nature survey of more than 3,200 scientists found those who run labs have a much more positive view of the dynamics in their research groups than do their staff. Nature concluded that a lack of training in leadership and management is one of the strongest contributors to an unhealthy lab culture (Van Noorden, 2018). As expected, this resentment of the interference of training with "real work" permeates the culture, and there is low uptake of training for ECRs as discussed in Findings above in this chapter.

I share these views, as well as those expressed in the report of the Wellcome Trust (2020) which recommends training to build stronger and more ethical leadership. Accredited training must be provided for both current and future leaders to help them understand the benefits to all of a more nurturing and supportive environment, to help them promote equity and diversity and to give them the skills to stamp out the poor practices. This will ultimately bring sustainable ethical practices which permit researchers to thrive and engender public trust.

The Royal Society (the independent scientific academy of the UK, dedicated to promoting excellence in science for the benefit of humanity) has set similar goals to make sure the research culture enables not only excellent research, but also supports the research community (Karlin, 2019). The Society has instituted a program to explore how the UK can promote the cultural conditions that will best enable excellent research and researchers to

flourish in the future. They focus on themes which include setting culture to acknowledge the role and influence of leaders on setting positive values and behaviours, and fostering scientific leadership, recognising the difference between leading scientists (advancing their field of research) and scientific leaders (supporting and developing researchers in their field).

The Royal Society believes a positive research culture is associated with minimising the pressures on researchers (funding, deadlines, quantity of outputs) and creating nurturing environments in which researchers can thrive (collaborative space, more generous timelines, career growth opportunities). Such culture is thought to be enabled by permitting researchers to be given time to do blue-sky thinking, risky research, synthesis and replicability studies; funding people not projects; allowing researchers to pursue different careers in teaching, charities, public sector and industry; providing shared places for collaboration and interaction and by ensuring research leaders should communicate well and know how to develop the talents and skills of their research teams.

Better leadership practices supporting suggestions such as those above can be expected to improve the poor level of satisfaction with the leadership and management of their workplaces (only 48% of my respondents reported they were satisfied) and with the workplace culture (51% satisfied).

6.3.2.2 Improve Supervision and Extend Mentoring

Better leadership, as recommended above, will help to address the problems lying behind by my findings that 60% of on-line survey respondents had been impacted by lack of support from institutional supervisors. Training in “how to be a good supervisor” and/or “how to be a good mentor” - and an expectation from leadership that the recommended practices should be followed - would be of great benefit to all as active mentoring from the supervisor and others has been shown to bring great benefit to ECRs, and indeed to all scientists

throughout their careers (Lee, 2007; Woolston, 2019). The National Science Foundation (NSF) recognised the importance of supervisory and mentoring relationships by introducing a mandate in 2009 requiring principal investigators to include a mentoring plan for all postdocs funded through their grants. That only 68% of my respondents had taken part in an annual review, and of those who had a review only 44% found it useful is another indication of poor supervision. I recommend that this proposed supervisor training should include management of regular reviews.

This proposed leadership training must be accompanied by a change in the culture, which should emanate from the top, so there is an expectation and requirement that supervisors meet defined standards of care for those in their charge. Institutions must encourage – and expect– proper supervision practices such as those which would be found in the commercial environment. At the same time, I strongly recommend the culture should recognise the efforts of those who offer their services to mentor people who are not in their direct team or to otherwise make a contribution to either the value of the institution or the field. This value of type of service appears not to be formally recognised in current practice as a measure of success for research leaders.

In conjunction, I encourage any institution which does not have a formal mentoring program or a culture of informal mentoring, to establish one to ensure that ECRs have the benefit of wise counsel from an independent advisor(s) who is not their supervisor. Mentoring should ultimately be of benefit to both the mentee and mentor; it can come at minimal or no cost, other than that of time and can provide great value (Christian, 2018; Christian & Scott, 2019).

6.3.2.3 Address Questionable Research Practices

Within the need to improve workplace culture in the research environment is the need to address the questionable research practices prevalent in some institutions. In Australia we are – or should be – guided by the Australian Code for the Responsible Conduct of Research (Australian Research Council & Universities Australia, 2018), however, as demonstrated in Chapter 4, there is evidence from this study of toxic working cultures in Australia where we find researchers impacted by workplace stress, poor supervision, bullying and harassment on the basis of power and questionable research practices. Australia is not alone in this, as can be seen in the literature which has provided evidence of researchers complaining of a pressurised, insecure and overly-competitive working environment where problems ranged from bullying and harassment through to the expectations of long hours, limitations on time off and a continual pressure for results (Smith, 2020; Wellcome Trust, 2020).

Horbach et al. (2020) recommend improved reporting procedures for those impacted by unacceptable practices so that junior researchers and others with short term contracts are empowered to address the issues which impact research integrity and cannot readily be rectified due to power imbalance. In addition to a recommendation to include training for leadership to recognise and deal with questionable research practices, I recommend the implementation, in every research institution, of better and safer methods by which vulnerable staff may report inappropriate research practices and expect to have them addressed (in accordance with the Guide to Managing and Investigating Potential Breaches of the Code (National Health and Medical Research Council et al., 2020)). This recommendation has previously been expressed in the Research Ethics Monthly article (Christian et al., 2020a) included in Section 3.8.2.

6.3.2.4 Address Sexual Harassment

The issues faced by women can be different from those faced by men. These are not just caring-related matters but also the very real burden of sexual harassment which is more significantly a problem for women, and which has been extensively addressed by Science and Technology Australia (STA) in their submission "Sexual Harassment in the Workplace" to the Australian Human Rights Commission (Science and Technology Australia, 2019).

Although there was no specific question about sexual harassment in the on-line survey, my project has collected clear evidence of sexual harassment against women as well as the possibility of sexual harassment affecting men. I endorse the recommendations of STA included within their submission:

- Formal adoption of the Principles for Respectful Supervisory Relationships by all organisations in the STEM sector
- Any action plan addressing sexual harassment in Australian STEM workplaces must explore and test solutions to eliminate barriers to reporting
- Those found guilty of sexual harassment should have their access to federal research funding through the Australian Research Council and the National Health and Medical Research Council revoked, and professional honours stripped
- Mandatory reporting of sexual harassment cases by research institutes to federal funding bodies
- STEM workplaces must have a sexual harassment policy and code of conduct that provides clear instructions for reporting and responding to workplace sexual harassment that occurs off-site

- Legislation be introduced to prevent non-disclosure agreements and confidentiality clauses from being used to prevent survivors speaking about their experiences

6.3.2.5 Provide Orientation for New ECRs

A good, and perhaps obvious, introduction to life as an ECR would be provision of orientation, however this appears not to be common practice. Only 28% of on-line survey respondents said they had received useful institution-wide orientation and 29% received useful department-wide orientation when they started their positions; only 41% had received useful induction into their actual role. One can only imagine how much time was wasted for people trying to find their way around for those who did not receive adequate support. The Flinders Fast Start Program introduced at Flinders University recently (Delpin, 2019), and with great success, provides a good example ECR orientation for other institutions to follow and shows ECRs, from the very beginning, that the institution is interested in their welfare.

6.3.3 Recommendations: Address Inequity

- Provide Active Assistance to Parents of Young Families
- Address Lack of Gender Diversity
- Address Inequity on the Basis of Ethnicity, Sexual Preference or Disability

In this section I provide recommendations regarding inequity. This is not just gender inequity, but inequity affecting all people with caring responsibilities as well as inequity on the basis of ethnicity, sexual preference or disability.

6.3.3.1 Take into Account the True Disruption to Careers Brought by Family Commitments and Provide Active Assistance to Parents of Young Families

Given that in our society wider family caring responsibilities, as well as caring for children, often still fall mostly to women, the impact of caring responsibilities on women's career progression in particular is obvious. STEMM institutions should ensure that all ECRs can fully participate in the research workforce and be guaranteed access to a range of flexible employment, return to work, and training opportunities. These conditions are not currently available for all, as demonstrated in Christian et al. (2021) and further discussed in Chapters 4 and 5.

As explained by Doherty & Manfredi (2006) and supported by this research, the most obvious reason for reduced productivity for women is their reduced discretionary time to conduct research and write papers during the periods in their lives when they have responsibility for young children. It is recommended that institutions actively acknowledge this conflict between the needs of home and work make allowances for reduced output and/or make provision for time working on papers, not while on maternity leave or days off, but during paid working hours.

Much is being done in Australia to address concerns about women, however, further to the content of the preceding paragraph, I suggest emphasis should be placed on parents of young families, whatever the gender. Anecdotal evidence suggests a change in culture to make it more acceptable for both parents to share the care of family appears to be developing in Australia, and I support the conclusions of Liang et al. (2019) who suggest women might be better helped by interventions that do not focus unduly on gender. Liang et al. recommend interventions likely to improve surgical training for both women and men because many factors, such as long working hours and unpredictable lifestyle affect all ECRs, while

changing societal expectations mean that previously “female factors” (p.547), such as childrearing, are increasingly shared. There is also a sense of equality in the idea that work done to advance the cause of women in surgery (certainly applicable to all in STEMM) need not do so at the expense of their male colleagues.

6.3.3.2 Address Lack of Gender Diversity

There are many ways in which increasing gender diversity can be readily addressed and which will encourage women to stay in the STEMM environment. These include offering role models, mentoring of women by women, ensuring equal representation on committees and panels, however holding team meetings at family friendly times and providing child-care will help all with young families. These interventions are addressed below.

In some institutions, staff at all levels are offered extra support in their laboratories while experiencing a career disruption, offered technical support while on maternity leave or are the beneficiaries of special advocacy programs (Dunstone & Williamson, 2016). Women are also invited to present their work at a conference and bring their children (Misra et al., 2012). Misra et al. point out that since sacrifices in research time as a result of career disruption are potentially detrimental to the research institutions themselves, policies that can help staff with high care demands remain engaged in research are very important In addition to provision of parental leave, implementation of policies that reduce or modify teaching and or service requirements during intensive child or elder care-giving periods would reduce the likelihood that research will always be the first thing to be sacrificed.

6.3.3.3 Address Inequity on the Basis of Ethnicity, Sexual Preference or Disability

There was little evidence of other inequity such as inequity on the basis of ethnicity, sexual preference or disability in data collected in this project (Christian et al., 2021), however it is likely that our sample did not include those for whom English is not a comfortable language, thus reducing evidence of racial bias, and was too small to hear the voice of those impacted by prejudice against their disability or sexual preferences. Nonetheless, universities should be required to implement the code of practice they might already have in relation to equality and make public a profile in terms of gender, race and disability to demonstrate where there might be imbalances. It is important that universities be transparent about their diversity targets and about their levels of success in achieving them, as recommended by Gewin (2020).

Rather than aim for targets based on mere numbers, perhaps the aim should be to train researchers to be inclusive so that "outsiders" (a definition that may include, in many workplaces, women) who currently may feel permanently uncomfortable are encouraged to be part of the team.

6.3.4 Recommendations: Provide More Professional Development Opportunities

- Provide and Encourage Participation in Training
- Provide and Encourage Participation in Career Planning
- Provide Assistance for Planning for Alternate Careers
- Provide Other Professional Development

The academic research career in STEMM is different from some other disciplines in that there are no professional development requirements such as are found for doctors or accountants. Nor, unlike for, say, engineering or architecture, is there preparation during undergraduate or PhD training for "on the job" skills, beyond the essential research skills.

While the research science PhD is a requirement for future employment, it typically focuses on a particular research question and that is its limit. My personal experience has shown me it is once the new ECR is employed in their first independent position where they are essentially running a small business that the lack of generic skills is identified, yet as shown above in this chapter this training is often either not available or not taken up.

In providing professional development opportunities, research institutions should examine ways to make the ECRs more competitive for their funding, and more secure in scientific employment. At the same time, this extra training (particularly on topics such as budget and project management) will save the need for much of the support currently provided by university administrators who assist ECRs who find themselves "out of their depth" (Tate, 2020).

6.3.4.1 Provide and Encourage Participation in Training

As shown in Section 6.2.2, the ECRs who responded to my on-line survey showed they have limited focus on their professional development, either for training or career planning. Looking first at training, they frequently fail to take up even the training opportunities which are related to their core research and academic work, although where training is taken, it is likely to be for the skills which are directly associated with their research outputs including training for specific research skills and techniques and grant writing. The ECRs report that courses they would like to attend are not always offered, and while generic management skills training might be offered, and of interest, they say they "have no time" to do it. This result supports Walton et al., (2018) who found 41% of respondents said there was insufficient skills development in their workplace over the previous 12 months.

The highest ranking courses in the category "would like to have taken but not available" are courses commonly recommended for broad professional development such as project management, managing IP, writing and publishing or communication skills (Gascoigne, 2012; Robbins & LePeau, 2018; Wisker et al., 2019). I recommend research institutions should offer courses in these topics – and the types of training resources the ECRs might actually use (such as my book (Christian, 2018)) - in order to increase participation and to equip the ECRs with appropriate skills for future leadership positions, whether in academic research or in other areas of science.

I also recommend that institutions encourage the uptake of training topics defined as "generic management skills", as has been recommended by others (Hardy et al., 2016; Tregoning & McDermott, 2020), and as included in Vitae's Concordat (Vitae, 2019). These generic skills will support ECRs in a career in academic research or will be useful to make them competitive for jobs outside research. I am disappointed in the low uptake of generic management skills by Australian ECRs and suggest they are just as important within research as elsewhere (Edwards et al., 2011; Gascoigne, 2012; Manathunga et al., 2007). Consequently, I am encouraged by the launch in 2019 by the Australian Academy of Science of a pilot program "Transferable Skills Toolkit" recognising that, traditionally, EMCRs do not receive adequate professional development opportunities during their career. This Toolkit will provide a professional development resource which aims to equip future STEM leaders, irrespective of discipline, sector, and profession, with transferable skills that are imperative in all career paths (Australian Academy of Science, 2019).

My view is that universities should encourage – indeed, expect – ECRs to engage in training and other professional development - and pay for it for the trainees.

While outside the scope of this study, I note there is some research into the value of training and its contribution to career planning for higher degree research students. This includes the tool developed by Manathunga et al. (2007) mentioned previously. Edwards et al. (2011) recommend further support should be provided to students during their degree to prepare them for work outside the university sector and/or for the academic tasks of teaching, research and administration and point out the importance of simultaneously ensuring a balance between the alignment of the research degree with the realistic career ambitions of students. I endorse this view.

6.3.4.2 Provide and Encourage Participation in Career Planning

The value of career planning, another aspect of professional development during the postdoctoral period I explored in this project, is becoming recognised as shown in the work of Vitae in the UK (Bogle et al., 2018; Mellors-Bourne & Metcalf, 2017) and Max Planck Institutes in Europe (Jahn, 2018), the National Institute of Health, USA (Gilliland et al., 2017) and in New Zealand (Sutherland, 2018a, 2018b, 2018c).

There is little evidence of prior research into the views of the ECRs themselves about their career planning, in spite of the uncertain nature of a research career (Signoret et al., 2018). In their work about research careers (all academic disciplines) in Australia, (McAlpine et al., 2013) reflected we know little about the ways individuals perceive and navigate the transition from their PhD to new careers; there appears to be little other research which looks past these first steps. I have sought to fill this void and have shown that outside taking advice from supervisors and perhaps mentors, who often have little experience of opportunities in the wider world, there are few resources to assist with career development and planning.

Although, as mentioned above, career planning information is now sometimes provided for Australian postgraduate students by their research institutions, I have shown

there is little evidence of it for those in the postdoctoral period. The research institutions appear to show little concern for the futures of the ECRs who work in a very insecure environment as demonstrated by limited, or often no, formal support by provision of either career advisory services or other sources of career planning information.

Although contracts for most ECRs are short term, as shown in Chapter 5 my results show only about a third of the ECRs agree they have a clear career development plan. While 62% of respondents report they are encouraged to engage in their personal and career development and 79% say they take ownership of their career development, there is little evidence that is, in fact, true. It could be expected that ECRs give a lot of thought to their next steps in their insecure environments however, supporting earlier Australian work (Australian Society of Medical Research, 2016; Laudel & Gläser, 2008; National Tertiary Education Union, 2012; Norton et al., 2018), my on-line survey indicates we have a highly skilled workforce permanently worried about securing their next funding and/or their next job while not actually planning a reasonable future path.

Elsewhere (Christian, 2018) and like others (Dudovskiy, 2014; Hardy, 2014) I recommend that, as they progress, ECRs need to determine what steps need to be completed for their next career move. The research institutions should offer guidance for career planning by providing appropriate internal training so ECRs can learn to draw up these career plans as is currently offered in the United Kingdom (Association of Graduate Careers Advisory Services, 2020). As with other training, their supervisors should encourage, or, if necessary, enforce, its uptake.

In the light of the insecure nature of research in STEMM I believe institutions should offer career counselling services for the ECRs in STEMM and, at the same time, work to change the culture so that these services are actively sought after.

6.3.4.3 Provide Assistance for Planning for Alternate Careers

As academic research is so strongly preferred, alternate careers are considered reluctantly and are viewed as being for failed researchers (Åkerlind, 2005; Payne, 2019; Zaringhalam, 2016). I endorse the view of Payne (2019) who has called for a cultural change and for supervisors to understand that they are not creating a "mini-me" (p.136) but instead need to develop understanding about different career paths which might be available to their team members. This may well require the institutions to provide training for the supervisors as well as the services of career advice and planning professionals.

While there are very good reasons for Australian scientists to consider alternate science careers, the principal reason being that there are far more people qualifying with a PhD than there are academic jobs, my on-line survey shows ECRs give little consideration to the value of these careers, supporting the views of Bell and Yates (2015) who found a transition away from academia would not sit comfortably for many with their identity as a scientist and researcher. There appears to be little other research on the perceptions of ECRs in academic STEMM fields in Australia on alternate careers although there has been some discussion on the values of "starting the conversation" (EMCR Forum, 2016). Further, my on-line survey shows when they will consider alternate careers, many of my participants believe that they would not be attractive to employers outside academia, as shown in this quote from a survey participant "I do not have the skills for any other job except research" (Survey respondent 688).

Many researchers, including several who took part in the in-depth interviews, hold a real fear that if they leave academia for other careers that it would be impossible to return to a research-only career, mostly because of the disruption to their publication and funding records, the key measures of success in academia (Bell & Yates, 2015; EMCR Forum, 2016).

> I applied for a range of academic, research, technical, managerial and information technology positions that had more clear future prospects. The private sector did not seem interested in my academic background. Retraining is an option, but is likely to come at a significant cost to my current academic path. (Survey respondent 479)

I recommend that career counselling services should provide advice for careers in a wide range of employment areas, not just academia. An important contribution would be to show the pathways to the many and varied alternate careers available outside academia (Rochen Renner, n.d.; Woolston, 2018; Zaringhalam, 2016). Ideally, in this environment where there is a shortage of research funding but a wish to build strength in STEMM industries, Australian institutions should be encouraged to take the approach adopted by Vitae and prepare their ECRs for career in science at large, not just academia. This will take another cultural change: alternative careers can be seen to be good!

Support for career development and career planning in Australia in the form of grants from the National Careers Institute, announced in 2020, is a welcome initiative (National Careers Institute Partnership Grants – Round One, 2020). This scheme aims to build an evidence-base for best practice career development, demonstrate the value of career development, increase knowledge and create greater awareness of career paths and career information, and develop and showcase innovative approaches to delivering career development services. I recommend that our research institutions apply for further rounds of this competitive funding and use it to address all the issues highlighted above for those employed in academic research in STEM disciplines.

Noting there are too many people with science PhD's for academia, but significant demand for people who are highly educated in the sciences, Gould (2015) has proposed the

PhD should be split in two so that one branch is prepared for academic research and the other for use in alternate science careers. This idea is worthy of consideration. Although training during the PhD is outside the scope of this work I feel it would also be wise to start preparation for life post-PhD during the PhD period, as recommended by Mewburn et al., (2017) and McGagh et al. (2016). This training has perhaps been introduced in some Australian universities in recent years although evidence for it has not emerged in my on-line survey or in recent literature.

6.3.4.4 Provide Other Professional Development

Provision of networking opportunities, travel money for attendance at conferences or visiting potential collaborators interstate or overseas as well as provision of opportunities for internal information exchange and interdisciplinary collaboration within institutions are additional, inexpensive means which can be readily utilised to further extend the professional development of ECRs. While these supports are available at some institutions, such funding is traditionally in low supply.

6.3.4.5 Conclusion for Provide More Professional Development Opportunities

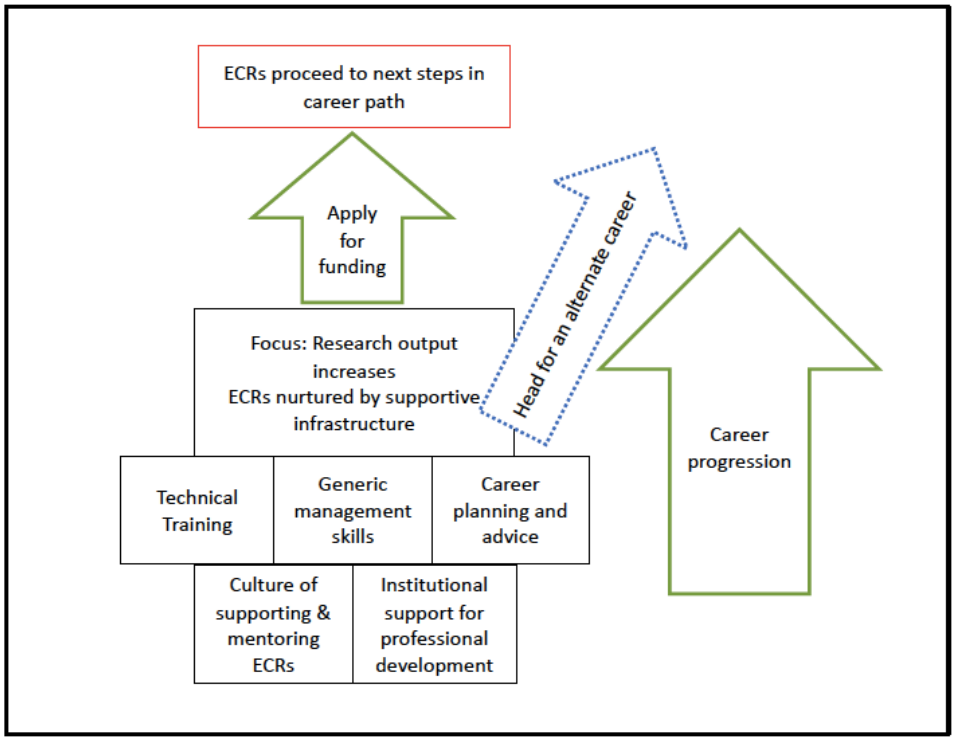
In summary, my findings show the culture within the STEM environment in Australia does not support the value of professional development, either of training, particularly generic management training, or of career planning. I recommend institutions should find ways to engage ECRs in their professional development. Institutions should offer the training they need, preferably in formats that encourage them to want to attend. Institutions and researchers should understand the value of that training and paying attention to their career planning will be beneficial for successful long-term career in science.

Many authorities in the field (Bogle et al., 2018; Browning et al., 2017; McKeon et al., 2013) agree the next generation of the STEM workforce needs to be fostered and organisations involved in higher education and research are being encouraged to consider following the successful examples set by Vitae in the UK, NIH in USA, Max Planck Institute and in New Zealand where there is now an emphasis on researcher development.

I believe publicly-funded Australian institutions have a duty of care to these early-career scientists and to Australians who need a STEM workforce. In order to build the strong STEM workforce the Australian Government is promoting, academia will need to change its culture so that investment in preparing scientists for a successful career, whether in academia or elsewhere, is regarded as an essential component of the postdoctoral period. These institutions need to look after ECRs as individuals and valued staff members, not as short-term workhorses and a replaceable resource.

Figure 41:

Potential Outcomes from Supportive Professional Development



I recommend career support for early career academics in the sciences, through training and career planning advice, be made a national priority within the higher education sector. Some of the potential benefits of such supportive professional development are demonstrated in Figure 41.

6.3.5 Recommendations: Change the Ways We Measure Impact

The standard means of measuring impact of those working in academia has been to count papers (and or journal impact factors) and successful funding which, as demonstrated, contributes to the levels of stress for STEMM staff. Although the means of measuring the success of universities has changed to include a measurement of engagement and impact known as Excellence in Research Australia ERA (Australian Research Council, 2019) the change has not yet moved to measurement of the contribution of individuals. There are many

people now contributing to the debate about how to best measure success for researchers. One such conversation is being conducted by the Australian Association of Medical Research Institutes (AAMRI) which is bringing together researchers and grant offices from across the country to plan more effective means for recognition of a wider range of contributions which will take into account the variety of contributions that transform research into impact on practice and policy. (AAMRI, 2020). It is also a subject receiving attention from the Australian Research Management Society a consequence of the changes to ERA.

I endorse the view, shared by many (including Acton et al., 2019; Algra et al., 2020; Smith, 2020) that all universities and research institutes should endeavour to take a wider view of measuring an individual's success in academia. Given that feeling valued has been shown to be an important factor for job satisfaction and, to the contrary, poor supervision has been found to be detrimental to the careers of many ECRs, steps should be taken to recognise and reward good supervision and mentoring. Promotion or salary increases for academic staff within universities and research institutions could be dependent in part on meeting specific goals relating to supervisory or mentoring responsibilities.

The value of contributions to the field by means other than publishing, such as participating in peer review, service on committees or meeting management could also be formally recognised. All these are activities which are currently expected of people but are not necessarily recognised and are certainly not rewarded. A recent position statement from Science Europe (2020) supports this view, calling for reviewers to assess a researcher's output or grant application for its potential for economic and societal impact or potential for commercialisation, as well as its contribution to knowledge and/or policy.

I now move to Recommendations Section 6.3.6 and 6.3.7, which have been a tangential outcome of my research.

6.3.6 Recommendations: Re-consider the Need for Gatekeeper Approval

As discussed in Chapter 3 and Christian et al. (2019), the need to seek and gain approval to approach staff members from universities and research institutes to take part in this project was cumbersome, time consuming and ultimately resulted in a bias in the sample of participants. I urge university Human Research Ethics Committees to review their interpretation of the National Statement on Ethics and confine the requests for gatekeeper approval to situations where the potential participants, or their institutions, could be in any way at risk from taking part in the research. Where potential participants are in a position to form their own considered opinion, without detriment to their employer, there should be no requirement for this gatekeeper approval. Should this proposed change cause concern, it would be reasonable to require writing to advise the gatekeeper that this ethically approved research is planned.

6.3.7 Recommendations: Improve Access for Outsiders to University Information

The requirement to obtain institutional approval before conducting my on-line survey, discussed in Chapter 3 and within it, Christian et al. (2019), drew attention to the fact that universities need to improve their management of contact information for key staff on their websites. I wrote letters to many Deans, and others in positions of equivalent authority, only to have the emails ultimately returned (often after long periods) because that person was no longer the incumbent. This added significantly to the frustrations and time delays of an already arduous process.

This need for approval also suggests that it would be helpful if universities would provide information on required processes for outside researchers to make contact with the appropriate people within the university. This information could well be beneficially provided

to those inside the university as well as it was rare to find someone familiar with how to go about the correct steps.

As explained in Chapter 3, the difficulties which attended this requirement for approval to conduct the research with university staff significantly hampered the progress of the research to the extent that it seems likely that someone not entirely familiar with the university system would find it impossible. If the process were clearer, outsiders could more readily conduct this type of research.

6.3.8 Summary of Recommendations

In summary, I have recommended ways to improve the institutional culture in STEMM workplaces by provision of leadership training to encourage improved supervision and mentoring and addressing the questionable research practices which appear to be prevalent in many institutions. There are specific recommendations for addressing sexual harassment. Within Recommendations Section 6.3.2 I recommend promotion of inclusiveness from the very beginning by provision of orientation to ECRs when they join the institution.

In Recommendations Section 6.3.3 I have provided recommendations for addressing inequity in the workplace, particularly ways of looking after those with caring responsibilities. There are recommendations about dealing with gender inequity and for those with caring responsibilities.

In Recommendations Sections 6.3.4 and 6.3.5 I provide recommendations for improving professional development for ECRs by both provision of and encouragement to participate in training and career planning, including planning for alternate careers and offer suggestions for ways to measure impact other than by counting publications and the value of grant funding.

Last, in answer to somewhat unexpected findings, in Recommendations Sections 6.3.2 and 6.3.7 I recommend re-consideration of the need for gatekeeper approval for research in organisations such as universities and provide some suggestions for universities to improve access for outsiders to university information.

Addressing the funding issues – which is very important – is a matter for the government. Addressing these other recommendations would not be costly and would simply reflect good management. The academic STEMM workplace has been permitted to get out of hand and must be brought in line with the standards of other accepted workplace cultures.

6.4: Progress Already Instituted in Response to This Study

Some actions have already been instituted as a consequence of this project, largely as a result of significant interest in Christian et al. (2020b) which reached (as a pre-print) an Altmetrics score of 79. The paper has been cited by a group of researchers working in cardiovascular health who share my concerns (Climie et al., 2020). It has led to interviews with Nature News (Woolston, 2020a) and the Royal Society of Chemistry magazine, Chemistry World (Singh Chalwa, 2020); a feature in Nature Index (Conroy, 2020) to inclusion on the blogs PreLights (2020) and The Node (The Company of Biologists, 2020a, 2020b) and a commendation in Retraction Watch (Oransky, 2020a, 2020b) . I have also received invitations to contribute the two articles which have been published in the peer-reviewed Research Ethics Monthly (Christian et al., 2019, 2020a) included in this thesis. Inclusion in pre-Lights and the "Journal club" of The International Centre for the Study of Research on Twitter each required responses from our research data to further questions.

Further, with my co-authorship and informed by findings from this research, Professor Adrian Lee has begun refurbishment of his website on mentoring: http://www.guidelinesonresearchmentoring.com/discipline-specific-guidelines

Publication of this paper as a pre-print also led to invitations to speak at the 2020 Gender and STEM Meeting at University of Sydney (postponed to 2021) and to the University of Adelaide Medical School EMCR annual meetings in 2019 and 2020. It has also generated a great deal of activity on Twitter and in LinkedIn.

6.5 Afterword: Impact of COVID-19

It must be noted that the data for this project were collected during 2019, prior to the impact of COVID-19 on Australia and, within Australia, on the research environment. It can only be expected that a situation which was already difficult for junior researchers will have been made worse due to the expected impact on research funding (Climie et al., 2020; Levine & Rathmell, 2020; Woolston, 2020b). Particular concerns about the consequences for women in STEMM have already been expressed in the literature (Buckee et al., 2020; [Editor, Nature], 2020); Gewin, 2020; Johnston, 2020; Myers et al., 2020) although one paper has expressed hope that it will help address on-going gender equity difficulties (Sansom-Daly & Ford, 2020). Beyond this, this thesis is able only to address the situation as it was prior to COVID-19.

6.6 Limitations

As participants in the survey self-selected, it is possible more dissatisfied people participated in the study than is representative, or participants may have been restricted only to people who had the time available to respond. Also, as this survey was long and conducted

only in English, people from culturally and linguistically diverse backgrounds may be under-represented.

As has been described above, is not possible to know the response rate to invitations received by potential participants It has also proven difficult to obtain the total number of ECRs in Australia who meet the eligibility requirements of the survey. The number is estimated to be approximately 10,000, based on the number of PhD completions, (average about 2,500 PhD completions in the sciences every year from 2009-2018) (Department of Education, Australian Government, 2019) and the estimated likelihood, approximately 50%, of them entering employment in higher education (McCarthy & Wieke, 2019) and staying in academic research for less than ten years. There were approximately 25,000 higher education staff in Level A and B positions (all disciplines) in 2018 (Australian Government, 2018) but it is not known how many of these are in the STEMM disciplines. Hardy et al. (2016) estimated the number of postdoctoral researchers employed in Australia as 6,000 but it seems likely this estimate is low.

The sample is representative by discipline. The differences between our sample and the target population are not statistically significant (chi square = 16.344, df = 9, p = 0.06).

As acknowledged in Section 3.8.6.1 there were only eight interviews. By the time I had the completed the eighth interview, it appeared the interviews had reached saturation of experiences for ECR women within the academic environment and no significant new points were raised. As explained above, I sought to balance the number of interviewees with the value of the data.

6.7 Opportunities for Further Research

Through this thesis I have identified several opportunities for further research. These include (in no particular order):

- the meaning, to ECRs of questionable research practices
- the impact of questionable research practices on ECRs
- the impact of bullying and harassment on ECRs
- the impact on ECRs of inequity on the basis of race, gender or sexual preference
- further examination of the needs of clinician researchers
- reasons for leaving research for ECR men (i.e. repeat of the interviews with women)
- the differences between men and women (if any) in time available for research
- general follow up of the cohort (which is possible, as 151 respondents supplied contact details)

6.8 Conclusion

This project has clearly identified that all is not well within academic STEMM in Australia and there are many problems which require urgent attention. The importance of this research to the STEMM research community is emphasised by both the international response to our pre-print manuscript (detailed in Section 6.4) and by responses to a summary of the research findings circulated at the end of the project to research participants, "gatekeepers" and those who had otherwise assisted. Some of those responses are reproduced below (with appropriate permission) and together present a conclusion which demonstrates the value of the research:

"Please don't hesitate to get in touch if we can help you with future research. I do see a lot of stress and long hours for ECRs trying to establish themselves. As we have medical related start-up commercial companies …too, I also see how easy it is for these companies to recruit talented people from within our institute; people who are eager to leave academia and find job security very alluring." (Senior manager, major research institution)

"Thank you for sending through your considered outcomes. We have recently received our Athena Swan Bronze accreditation. This is very timely." (Director, Research Office, regional university)

"The findings are very, very sobering and point to a dark corruption at the heart of research and science in this country. I would like to circulate your documents to:

- ECR community at [institution]
- Faculty and Executive at [institution]
- The Academy of Health and Medical Sciences ….."

(Professor, major research institution)

"all the best for research into the future. I think it is very important (I was once an ECR in STEMM too)" (Senior staff member, Go8 university)

"I am also interested to see how the sector can transform into the kind of sector many of us want it to be. Your work has been an important part of the drive for change." (Mid career researcher, and executive member of a scientific "umbrella group")

"We have just set up a committee at [institute] to address E/MCR issues- am I able to share with them?" (Research manager, major research institution)

“These are disturbing results. If I was managing a department where 80% of my early career staff intended to leave - I'd hand in my resignation before the board sacks me.” (Professor Go8 university)

“I’ve also forwarded your research onto the Diversity & Inclusion team, as well as my colleagues in Science Policy.” (Analyst, science organisation)

“Kate these are really important data …Addressing issues around maximising research quality and eliminating (hopeful perhaps but we did it for COVID-19 and I didn’t think that was possible) research fraud in our Faculty is a major priority for me in 2021. Starts with a look under the bonnet, education and a drive to change culture.” (Professor Go8 university)

Chapter 6 References

AAMRI. (2020). The Research Impact Project. https://aamri.org.au/members/theresearchimpactproject/

Abbott, A. (2017). Super catalysts. Nature, 552, 139.

Acton, S. E., Bell, A., Toseland, C., & Twelvetrees, A. (2019). The life of P.I. - Transitions to Independence in Academia. BioRxiv. https://doi.org/10.1101/571935

Åkerlind, G. S. (2005). Postdoctoral researchers: Roles, functions and career prospects. Higher Education Research & Development, 24(1), 21–40. https://doi.org/10.1080/0729436052000318550

Algra, A., Koopman, I., & Snoek, R. (2020, March 31). How young researchers can re-shape the evaluation of their work. Nature Index. https://www.natureindex.com/news-blog/how-young-researchers-can-re-shape-research-evaluation-universities

Association of Graduate Careers Advisory Services. (2020). Supporting Research Staff and Students, July 2020: A report on careers provision for research staff and students across the UK and Ireland. Association of Graduate Careers Advisory Services. https://www.agcas.org.uk/Knowledge-Centre/SupportingResearchers

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. Social Research Update, Summer 2001(33).

Austin, J. (2007). Lab-Management Training—As Bad as We Suspected. Science. http://blogs.sciencemag.org/sciencecareers/2007/11/labmanagement-t.html

Australian Academy of Science. (2019). Home—STEM Transferable Skills Toolkit. Home. aas.eventsair.com

Australian Government. (2018). 2018 Staff numbers, Department of Education and Training. https://docs.education.gov.au/documents/2018-staff-numbers

Australian Law Reform Commission. (2009). The Fair Work Act 2009 (Cth). ALRC. https://www.alrc.gov.au/publication/grey-areas-age-barriers-to-work-in-commonwealth-laws-dp-78/2-recruitment-and-employment-law/the-fair-work-act-2009-cth/

Australian Research Council. (2019). Engagement and Impact Assessment 2018-19 National Report. Australian Research Council. https://dataportal.arc.gov.au/EI/NationalReport/2018/

Australian Research Council, & Universities Australia. (2018). National Health and Medical Research Council: The Australian Code for the Responsible Conduct of Research.

Australian Society of Medical Research. (2016). The 2016 ASMR Health and Medical Research Workforce Survey. Australian Society of Medical Research. https://asmr.org.au/wp-content/uploads/library/Workforce16.pdf

Baranyi, K., Bowles, J., Hassan, S., Prinsley, R., Smith, P., Walter, C., Australia, & Office of the Chief Scientist. (2016). Australia's STEM workforce: Science, Technology, Engineering and Mathematics. Office of the Chief Scientist, Australian Government - Department of Industry and Science.

Basak, S. K., & Govender, D. (2015). Theoretical Framework Of The Factors Affecting University Academics Job Satisfaction. International Business & Economics Research Journal (IBER), 14(2). https://doi.org/10.19030/iber.v14i2.9167

Bazeley, P., Kemp, L., Stevens, K., Asmar, C., Grbich, C., Marsh, H., & Bhathal, R. (1996). Waiting in the Wings: A Study of Early Career Academic Researchers in Australia. Australian Research Council and National Board of Employment Education and Training (NBEET). https://trove.nla.gov.au/version/217785130

Bell, S., & Yates, L. (2015). Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne.

https://womeninscienceaust.org/2014/06/15/women-in-the-scientific-research-workforce-identifying-and-sustaining-the-diversity-advantage/

Bhakta, D., & Boeren, E. (2016). Training needs of early career researchers in research-intensive universities. International Journal for Researcher Development, 7(1), 84–102. https://doi.org/10.1108/IJRD-06-2015-0017

Bogle, D. (2018, June 27). How could universities and funders improve the situation for postdoctoral scientists? NatureJobs. http://blogs.nature.com/naturejobs/2018/06/27/how-could-universities-and-funders-improve-the-situation-for-postdoctoral-scientists/

Bogle, D., Compton-Daw, E., Elvidge, L., Gavaghan, D., Henstock, J., Jones, D., Normington, K., Rooney, C., Smith McGloin, R., Watson, D., & Wenham, M. (2018). Review of the Concordat to Support the Career Development of Researchers. Concordat to Support the Career Development of Researchers.

Boman, J. (2017). 2017 Career Tracking Survey of Doctorate Holders. European Science Foundation. www.esf.org

Briggs, C. A., & Pehrsson, D.-E. (2008). Research Mentorship in Counselor Education. Counselor Education and Supervision, 48(2), 101–113. https://doi.org/10.1002/j.1556-6978.2008.tb00066.x

Browning, L., Thompson, K., & Dawson, D. (2014). Developing future research leaders: Designing early career researcher programs to enhance track record. International Journal for Researcher Development, 5(2), 123–134. https://doi.org/10.1108/IJRD-08-2014-0019

Browning, L., Thompson, K., & Dawson, D. (2017). From early career researcher to research leader: Survival of the fittest? Journal of Higher Education Policy and Management, 39(4), 361–377. https://doi.org/10.1080/1360080X.2017.1330814

Buckee, C., Hedt-Gauthier, B., Mahmud, A., Martinez, P., Tedijanto, C., Murray, M., & Khan, R. (2020, May 15). Women in science are battling both Covid-19 and the patriarchy. Times Higher Education (THE). https://www.timeshighereducation.com/blog/women-science-are-battling-both-covid-19-and-patriarchy

Christian, K. (2018). Keys to Running Successful Research Projects: All the Things They Never Teach You (1st ed.). Academic Press. https://www.elsevier.com/books/isbn/9780128131343

Christian, K., Johnstone, C., Larkins, J., & Wright, W. (2019, September 17). The need to seek institutional approval to survey staff –was this a misunderstanding of the purpose of Guideline 2.2.13 in the National Statement on Ethical Conduct in Human Research? Research Ethics Monthly. https://ahrecs.com/human-research-ethics/the-need-to-seek-institutional-approval-to-survey-staff-was-this-a-misunderstanding-of-the-purpose-of-guideline-2-2-13-in-the-national-statement-on-ethical-conduct-in-human-research

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. (2020a, July 29). What are questionable research practices as reported by ECRs in STEMM in Australia? Research Ethics Monthly. https://ahrecs.com/uncategorized/what-are-questionable-research-practices-as-reported-by-ecrs-in-stemm-in-australia/

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. R. (2020b). Survey of Australian STEMM Early Career Researchers: Job insecurity and questionable research practices are major structural concerns. BioRxiv. https://doi.org/10.1101/2020.02.19.955328

Christian K, Johnstone C, Larkins J, Wright W, Doran MR. A survey of early-career researchers in Australia. Rodgers P, Deathridge J, Lijek RS, Rolf H, Hussain T, editors. eLife. 2021 Jan 11;10:e60613

Christian, K., & Scott, C. L. (2019). Establishing the Cure Cancer Australia Mentoring Program 2017: Setting up a Successful Mentoring Program Might Be Easier than You Think. Journal of Intergenerational Relationships, 0(0), 1–10. https://doi.org/10.1080/15350770.2019.1653143

Climie, R. E., Wu, J. H. Y., Calkin, A. C., Chapman, N., Inglis, S. C., Colafella, K. M. M., Picone, D. S., Tan, J. T. M., Thomas, E., Viola, H. M., Wise, S. G., Murphy, A. J., Nelson, M. R., Nicholls, S., Hool, L. C., Doyle, K., Figtree, G. A., & Marques, F. Z. (2020). Lack of Strategic Funding and Long-Term Job Security Threaten to Have Profound Effects on Cardiovascular Researcher Retention in Australia. Heart, Lung and Circulation, 0(0). https://doi.org/10.1016/j.hlc.2020.07.010

Conroy, G. (2020, July 8). Here's why so many young researchers want to quit – in five graphs. Nature Index. https://www.natureindex.com/news-blog/heres-why-so-many-young-researchers-want-to-quit-in-five-graphs

Davis, G. (2009). Science and Engineering Careers in the United States: An Analysis of Markets and Employment. In Improving the Postdoctoral Experience An Empirical Approach. University of Chicago Press. https://chicago.universitypressscholarship.com/view/10.7208/chicago/9780226261904.001.0001/upso-9780226261898-chapter-4

Delpin, M. (2019, September 19). Flinders Research Fast Start Program – an action-learning orientation and induction to mitigate research lag. Australasian Research Management Society, Adelaide.

Department of Education, Australian Government. (2019, June 4). Higher Education Statistics, Department of Education, Australian Government. https://www.education.gov.au/higher-education-statistics

Department of Industry, Innovation and Science. (2017). Australia's National Science Statement. Commonwealth of Australia. http://science.gov.au/NSS

Department of Industry Innovation and Science. (2018). Australia 2030: Prosperity through Innovation. Australian Government. https://www.industry.gov.au/data-and-publications/australia-2030-prosperity-through-innovation

Department of Industry, Science, Energy and Resources. (2020). STEM Equity Monitor—Summary Report 2020. Australian Government. industry.gov.au/stemequitymonitor

Doherty, L., & Manfredi, S. (2006). Women's progression to senior positions in English universities. Employee Relations, 28(6), 553–572. https://doi.org/10.1108/01425450610704498

Dudovskiy, J. (2014). Career planning and personal development plan. Research Methodology. https://research-methodology.net/career-planning-and-personal-development-plan-sample/#Personal_Career_Plan

Dunstone, M., & Williamson, B. (2016). Gender Equity: Current Issues, Best Practice and New Ideas.

[Editor, Nature]. (2018a). Health Tips for Research Groups. Nature, 557, 302–303.

[Editor, Nature]. (2018b). Survey reveals highs and lows of a life in science. Nature, 562, 459. https://doi.org/10.1038/d41586-018-07149-8

Edwards, D., Bexley, E., & Richardson, S. (2011). Regenerating the Academic Workforce. The careers, intentions and motivations of higher degree research students in Australia. Findings of the National Research Student Survey. Australian Council for

Educational Research. https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0009/1490940/RAW_Combined.pdf

Edwards, D., & Smith, T. F. (2008). Supply, demand and approaches to employment by people with postgraduate research qualifications in science and mathematics: Literature Review and Data Analysis. Australian Council for Educational Research.

Eigi, J., Velbaum, K., Lõhkivi, E., Simm, K., & Kokkov, K. (2018). Supervision, mentorship and peer networks: How Estonian early career researchers get (or fail to get) support | RT. A Journal on Research Policy and Evaluation. RT. A Journal on Research Policy and Evaluation, 6(1). https://riviste.unimi.it/index.php/roars/article/view/8709

EMCR Forum. (2016). Diiscussion Paper: Starting the conversation between academia and industry. Australian Academy of Science.

Franklin Women Mentoring Program. (n.d.). Retrieved 12 September 2020, from https://franklinwomen.com.au/mentoring/

Friesenhahn, I., & Beaudry, C. (2014). Global State of Young Scientists Project Report and Recommendations. Global Young Academy. https://globalyoungacademy.net/wp-content/uploads/2015/06/GYA_GloSYS-report_webversion.pdf

Gascoigne, T. (2012). Career support for researchers: Understanding needs and developing a best practice approach. Australian Council of Learned Academies Commissioned by the Department of Industry, Innovation, Science, Research and Tertiary Education.

Gewin, V. (2020). The career cost of COVID-19 to female researchers, and how science should respond. Nature, 583, 867–869. https://doi.org/10.1038/d41586-020-02183-x

Gibbs, K. D., McGready, J., Griffin, K., & F. Hatfull, G. (2015). Career Development among American Biomedical Postdocs. CBE—Life Sciences Education, 14(4), ar44. https://doi.org/10.1187/cbe.15-03-0075

Gilliland, C. T., Sittampalam, G. S., Wang, P. Y., & Ryan, P. E. (2017). The translational science training program at NIH: Introducing early career researchers to the science and operation of translation of basic research to medical interventions. Biochemistry and Molecular Biology Education, 45(1), 13–24. https://doi.org/10.1002/bmb.20978

Gonzalez, L. M., Wester, K. L., & Borders, L. D. (2019). Supports and barriers to new faculty researcher development. Studies in Graduate and Postdoctoral Education. https://doi.org/10.1108/SGPE-D-18-00020

Gould, J. (2015). How to build a better PhD. Nature News, 528(7580), 22. https://doi.org/10.1038/528022a

Grinstein, A., & Treister, R. (2018). The unhappy postdoc: A survey based study. F1000Research, 6, 1642. https://doi.org/10.12688/f1000research.12538.2

Hardy, M. C. (2014). Best Practices for Postdoctoral Progress. EMCR Forum.

Hardy, M. C., Carter, A., & Bowden, N. (2016). What do postdocs need to succeed? A survey of current standing and future directions for Australian researchers. Palgrave Communications, 2, 16093. https://doi.org/10.1057/palcomms.2016.93

Helbing, C. C., Verhoef, M. J., & Wellington, C. L. (1998). Finding identity and voice: A national survey of Canadian postdoctoral fellows. Research Evaluation, 7(1), 53–60. https://doi.org/10.1093/rev/7.1.53

Herbert, D. L., Coveney, J., Clarke, P., Graves, N., & Barnett, A. G. (2014). The impact of funding deadlines on personal workloads, stress and family relationships: A qualitative study of Australian researchers. BMJ Open, 4(3), e004462. https://doi.org/10.1136/bmjopen-2013-004462

Horbach, S. P. J. M., Breit, E., Halffman, W., & Mamelund, S.-E. (2020). On the Willingness to Report and the Consequences of Reporting Research Misconduct: The Role of

Power Relations. Science and Engineering Ethics. https://doi.org/10.1007/s11948-020-00202-8

Huang, J., Gates, A. J., Sinatra, R., & Barabási, A.-L. (2020). Historical comparison of gender inequality in scientific careers across countries and disciplines. Proceedings of the National Academy of Sciences, 117(9), 4609–4616. https://doi.org/10.1073/pnas.1914221117

Jahn, R. (2018). Max Planck Guidelines on the postdoc stage. Max Planck. www.mpg.de/guidelines-postdocs

Johnston, E. (2020). The impact of COVID-19 on women in the STEM workforce [Rapid Research Report]. Australian Academy of Science. https://www.science.org.au/covid19/women-stem-workforce

Karlin, L. (2019). Wellcome—Research Culture: Extended Review. Shift Learing.

Katz, R. (2016). Challenges in Doctoral Research Project Management: A Comparative Study. International Journal of Doctoral Studies, 11. https://pdfs.semanticscholar.org/99fb/d399cb47fc5e4eb4e6bfe011f0c9c10cf347.pdf

Kearney, K. A., Hopkins, R. H., Mauss, A. L., & Weisheit, R. A. (1983). Sample Bias Resulting from a Requirement for Written Parental Consent. Public Opinion Quarterly, 47(1), 96–102. https://doi.org/10.1086/268769

Lashuel, H. A. (2020). The busy lives of academics have hidden costs—And universities must take better care of their faculty members. Nature. https://doi.org/10.1038/d41586-020-00661-w

Laudel, G., & Gläser, J. (2008). From apprentice to colleague: The metamorphosis of early career researchers. Higher Education, 55(3), 387–406. https://doi.org/10.1007/s10734-007-9063-7

Lee, A. (2007). Nature's Guide to Mentors. Nature, 447, 791–797.

Levine, R. L., & Rathmell, W. K. (2020). COVID-19 impact on early career investigators: A call for action. Nature Reviews Cancer, 1–2. https://doi.org/10.1038/s41568-020-0279-5

Liang, R., Dornan, T., & Nestel, D. (2019). Why do women leave surgical training? A qualitative and feminist study. The Lancet, 393(10171), 541–549. https://doi.org/10.1016/S0140-6736(18)32612-6

Manathunga, C., Lant, P., & Mellick, G. (2007). Developing professional researchers: Research students' graduate attributes. Studies in Continuing Education, 29(1), 19–36. https://doi.org/10.1080/01580370601146270

McAlpine, L., Amundsen, C., & Turner, G. (2013). Constructing post−PhD careers: Negotiating opportunities and personal goals. International Journal for Researcher Development, 4(1). https://www-emeraldinsight-com.ezproxy.federation.edu.au/doi/full/10.1108/IJRD-01-2013-0002

McAlpine, L., & Emmioğlu, E. (2015). Navigating careers: Perceptions of sciences doctoral students, post-PhD researchers and pre-tenure academics. Studies in Higher Education, 40(10), 1770–1785. https://doi.org/10.1080/03075079.2014.914908

McAlpine, L., Turner, G., Saunders, S., & Wilson, N. (2016). Becoming a PI: Agency, persistence and some luck! International Journal for Researcher Development, 7(2), 106–122. https://doi.org/10.1108/IJRD-12-2015-0033

McCarthy, P. X., & Wieke, M. (2019). Advancing Australia's Knowledge Economy. University of Melbourne on behalf of AMSI and CSIRO Data61's Ribit net. https://amsi.org.au/publications/advancing-australias-knowledge-economy/

McGagh, J., Marsh, H., Western, M., Thomas, P., Hastings, A., Mihailova, M., & Wenham, M. (2016). Review of Australia's Research Training System: Final Report. Australian Council of Learned Academies.

McKeon, S., Alexander, E., Frazer, I., Ferris, B., Brodaty, H., & Little, M. (2013). Strategic Review of Health and Medical Research – Better Health Through Research. Australian Government, Department of Health and Aging.

Mellors-Bourne, R., & Metcalf, J. (2017). Five Steps Forward: Progress in implementing the Concordat to Support the Career Development of Researchers 2008-2017. Careers Research & Advisory Centre, Vitae.

Mewburn, I., Suominen, W. J., & Grant, H. (2017). Tracking Trends in Industry Demand for Australia's Advanced Research Workforce.pdf. Australian National University. https://cpas.anu.edu.au/files/Mewburn%2C%20Suominen%20and%20Grant%202017%20Tracking%20Trends%20in%20Industry%20Demand%20for%20Australia%27s%20Advanced%20Research%20Workforce.pdf

Miller, J. M., & Feldman, M. P. (2015). Isolated in the Lab: Examining Dissatisfaction with Postdoctoral Appointments. The Journal of Higher Education, 86(5), 697–724. https://doi.org/10.1353/jhe.2015.0029

Miller, T., & Boulton, M. (2007). Consenting to what? Issues of access, gate-keeping and informed consent. 2nd ed. Social Science & Medicine, 65, 2199–2211.

Misra, J., Lundquist, J. H., & Templer, A. (2012). Gender, Work Time, and Care Responsibilities Among Faculty. Sociological Forum, 27(2), 300–323. https://doi.org/10.1111/j.1573-7861.2012.01319.x

Moss-Racusin, C. A., Sanzari, C., Caluori, N., & Rabasco, H. (2018). Gender Bias Produces Gender Gaps in STEM Engagement. Sex Roles, 79(11), 651–670. https://doi.org/10.1007/s11199-018-0902-z

Myers, K. R., Tham, W. Y., Yin, Y., Cohodes, N., Thursby, J. G., Thursby, M. C., Schiffer, P., Walsh, J. T., Lakhani, K. R., & Wang, D. (2020). Unequal effects of the COVID-

19 pandemic on scientists. Nature Human Behaviour, 1–4. https://doi.org/10.1038/s41562-020-0921-y

National Academies of Sciences. (2018). The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through. https://doi.org/10.17226/25008

National Careers Institute Partnership Grants – Round One. (2020, March 30). Business.Gov.Au. https://www.business.gov.au/Grants-and-Programs/National-Careers-Institute-Partnership-Grants

National Health and Medical Research Council. (2016). Consultation Paper Structural Review. NHMRC.

National Health and Medical Research Council. (2018). National Statement on Ethical Conduct in Human Research (2007)—Updated 2018. Commonwealth of Australia, Canberra. https://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018

National Health and Medical Research Council, Australian Research Council, & Universities Australia. (2020). Guide to Managing and Investigating Potential Breaches of the Australian Code for the Responsible Conduct of Research. nhmrc.gov.au

National Tertiary Education Union. (2012). Independent Inquiry into Insecure Work: Submission of National Tertiary Education Union. https://www.actu.org.au/media/349566/national-tertiary-education-union.pdf

Norton, A., Cherastidtham, I., & Mackey, W. (2018). Mapping Australian higher education 2018. Grattan Institute. https://grattan.edu.au/report/mapping-australian-higher-education-2018/

Oransky, A. I. (2020, March 7). Weekend reads: A whistleblower is fired; problems in heart research; doing the right thing in science. Retraction Watch.

https://retractionwatch.com/2020/03/07/weekend-reads-a-whistleblower-is-fired-problems-in-heart-research-doing-the-right-thing-in-science/

Oransky, I. (2020, February 22). Weekend reads: An editor wonders whether data exist, 'how universities cover up scientific fraud,' detecting paper mills –. Retraction Watch. https://retractionwatch.com/2020/02/22/weekend-reads-an-editor-wonders-whether-data-exist-how-universities-cover-up-scientific-fraud-detecting-paper-mills/

Ovseiko, P. V., Chapple, A., Edmunds, L. D., & Ziebland, S. (2017). Advancing gender equality through the Athena SWAN Charter for Women in Science: An exploratory study of women's and men's perceptions. Health Research Policy and Systems, 15(1), 12. https://doi.org/10.1186/s12961-017-0177-9

Pain, E. (2014). An emerging global picture of early-career scientists. Science Careers. http://www.sciencemag.org/careers/2014/01/emerging-global-picture-early-careerscientists

Payne, D. (2019). The professional advisers who can help you to move from academia to industry. Nature, 567, 135. https://doi.org/10.1038/d41586-019-00747-0

Phillips, P., & Meacham, S. (2015). Submission to: Review of Australia's Research Training System. ASMR.

Powell, K. (2018). A kinder kind of science. Nature, 553, 367–369.

PreLights. (2020). Survey of Australian STEMM Early Career Researchers: Job insecurity and questionable research practices are major structural concerns—PreLights. https://prelights.biologists.com/highlights/survey-of-australian-stemm-early-career-researchers-job-insecurity-and-questionable-research-practices-are-major-structural-concerns/

Robbins, C. K., & LePeau, L. A. (2018). Seeking "better ways": Early career faculty researcher development. Studies in Graduate and Postdoctoral Education, 9(2), 113–126. https://doi.org/10.1108/SGPE-D-17-00029

Rochen Renner, B. (n.d.). LibGuides: Altac (Alternative Academic) Careers: STEM Resources. Retrieved 17 March 2020, from https://guides.lib.unc.edu/c.php?g=216166&p=1661253

Rosser, V. J. (2004). Faculty Members' Intentions to Leave: A National Study on Their Worklife and Satisfaction. Research in Higher Education, 45(3), 285–309. https://doi.org/10.1023/B:RIHE.0000019591.74425.f1

Rosser, V. J. (2005). Measuring The Change in Faculty Perceptions Over Time: An Examination of Their Worklife and Satisfaction. Research in Higher Education, 46(1), 81–107. https://doi.org/10.1007/s11162-004-6290-y

Rosser, V. J., & Tabata, L. N. (2010). An Examination of Faculty Work: Conceptual and Theoretical Frameworks in the Literature. In J. C. Smart (Ed.), Higher Education: Handbook of Theory and Research: Volume 25 (pp. 449–475). Springer Netherlands. https://doi.org/10.1007/978-90-481-8598-6_12

Rybarczyk, B., Lerea, L., Lund, P. K., Whittington, D., & Dykstra, L. (2011). Postdoctoral Training Aligned with the Academic Professoriate. BioScience, 61(9), 699–705. https://doi.org/10.1525/bio.2011.61.9.8

Sansom-Daly, U., & Ford, C. (2020, May 19). Could the COVID-19 lockdown solve one of the persistent barriers to gender equity in research? https://oncologynews.com.au/could-the-covid-19-lockdown-solve-one-of-the-persistent-barriers-to-gender-equity-in-research/

Science and Technology Australia. (2019). STA Submission: Sexual harassment in the workplace. https://scienceandtechnologyaustralia.org.au/wp-content/uploads/2019/02/STA-Submission-Sexual-harassment-in-the-workplace-.pdf

Science Europe. (2020). Position Statement and Recommendations on Research Assessment Processes. Science Europe. https://www.scienceeurope.org/our-resources/position-statement-research-assessment-processes/

Science in Australia Gender Equity. (2015). About Science in Australia Gender Equity (SAGE). http://www.sciencegenderequity.org.au/

Science in Australia Gender Equity. (2018). Putting Gender on your Agenda (SAGE). https://www.sciencegenderequity.org.au/wp-content/uploads/2018/12/SAGE_Report_44pp_ SCREEN.pdf.

Shaw, J., & Chew, Y. L. (2020, August 13). Early and mid-career scientists face a bleak future in the wake of the pandemic. The Conversation. http://theconversation.com/early-and-mid-career-scientists-face-a-bleak-future-in-the-wake-of-the-pandemic-144350

Shine, J., Bradlow, H., O'Reilly, S., & Godfrey, B. (2019). Women in STEM Decadal Plan (Australian Academy of Science) (p. 62). Australian Academy of Science. https://www.science.org.au/support/analysis/decadal-plans-science/women-in-stem-decadal-plan

Signoret, C., Ng, E., Da Silva Heil, S., Tack, A., & Voss, U. (2018). Well-Being of Early-Career Researchers: Insights from a Swedish Survey. Higher Education Policy. https://www.researchgate.net/publication/323073459_Well-Being_of_Early-Career_Researchers_Insights_from_a_Swedish_Survey

Singh Chalwa, D. (2020). Questionable research practices are hurting junior researchers. Chemistry World. https://www.chemistryworld.com/news/questionable-research-practices-are-hurting-junior-researchers/4011250.article

Singh, S., & Wassenaar, D. (2016). Contextualising the role of the gatekeeper in social science research. South African Journal of Bioethics and Law, 9(1), 42. https://doi.org/10.7196/SAJBL.2016.v9i1.465

Smith, D. K. (2020). The race to the bottom and the route to the top. Nature Chemistry, 12, 101–103.

Sutherland, K. A. (2018a). Chapter 8: Resources, Training and Support for Early Career Academics. In Early Career Academics in New Zealand: Challenges and Prospects in Comparative Perspective. Springer.

Sutherland, K. A. (2018b). Cultivating Connectedness and Generosity in Universities: A View of Early Career Academic Experiences in Aotearoa, New Zealand. On Education. Journal for Research and Debate. https://doi.org/10.17899/on_ed.2018.3.8

Sutherland, K. A. (2018c). Holistic academic development: Is it time to think more broadly about the academic development project? International Journal for Academic Development, 23(4), 261–273. https://doi.org/10.1080/1360144X.2018.1524571

Tate, C. (2020). Early career researchers: The role of project management, mentors and the pathway to success. Massey University.

The Company of Biologists. (2020a, February). February in preprints—The Node. The Node. https://thenode.biologists.com/february-in-preprints-4/highlights/

The Company of Biologists. (2020b, June). June in preprints—The Node. The Node. https://thenode.biologists.com/june-in-preprints-5/highlights/

Tregoning, J. S., & McDermott, J. E. (2020). Ten Simple Rules to becoming a principal investigator. PLOS Computational Biology, 16(2), e1007448. https://doi.org/10.1371/journal.pcbi.1007448

Van Noorden, R. (2018). Some hard numbers on science's leadership problems. Nature, 557, 294–296.

Vitae. (2012). What do researchers want to do? The career intentions of doctoral graduates Vitae Feb 2012.

Vitae. (2019). The Concordat to Support the Career Development of Researchers—Vitae Website. https://www.vitae.ac.uk/policy/concordat/full

Waaijer, C. J. F., Belder, R., Sonneveld, H., van Bochove, C. A., & van der Weijden, I. C. M. (2017). Temporary contracts: Effect on job satisfaction and personal lives of recent PhD graduates. Higher Education, 74(2), 321–339. https://doi.org/10.1007/s10734-016-0050-8

Walker, S., & Read, S. (2011). Accessing vulnerable research populations: An experience with gatekeepers of ethical approval. International Journal of Palliative Nursing, 17(1), 14–18. https://doi.org/10.12968/ijpn.2011.17.1.14

Walton, C., Walker, K., & Porter, R. (2018). Professional Scientists Employment and Remuneration Report. Professionals Australia. http://www.professionalsaustralia.org.au/financial-edge/salary-survey-reports/scientists5/

Wellcome Trust. (2020). What researchers think about the culture they work in. Wellcome Trust. https://wellcome.org/reports/what-researchers-think-about-research-culture

Wisker, G., Robinson, G. D., & Leibowitz, B. (2019). The purpose and impact of postgraduate knowledge. Studies in Graduate and Postdoctoral Education. https://doi.org/10.1108/SGPE-05-2019-0054

Woolston, C. (2018). Paths less travelled. Nature, 562, 611–614. https://doi.org/10.1038/d41586-018-07111-8

Woolston, C. (2019). Postdoctoral mentorship key to career success. Nature, 565, 667–667. https://doi.org/10.1038/d41586-019-00262-2

Woolston, C. (2020a, March 8). Australian junior scientists report damaging lack of support at work. Nature. https://www.nature.com/articles/d41586-020-00687-0

Woolston, C. (2020b). Junior researchers hit by coronavirus-triggered hiring freezes. Nature. https://doi.org/10.1038/d41586-020-01656-3

Zaringhalam, M. (2016, September 20). Why 'Alternative' Careers in STEM Aren't 'Alternative'. The Chronicle of Higher Education. https://chroniclevitae.com/news/1549-why-alternative-careers-in-stem-aren-t-alternative

Appendices

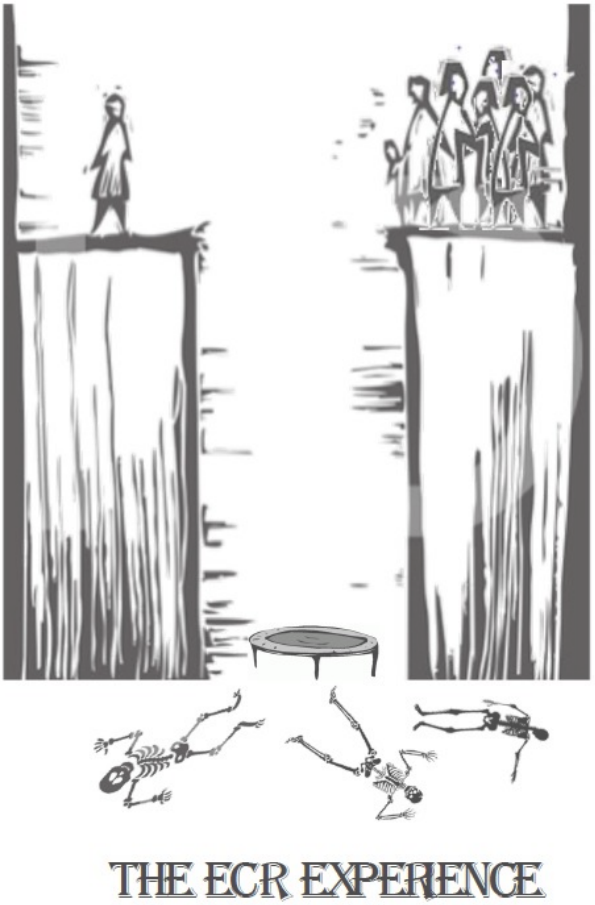


Image included with permission of Prof Don Newgreen

Appendix A: Ethics Documentation

Ethics Application

Ethics Approval

Ethics Amendments

Ethics Final Report

Ethics documentation follows on next pages

Approval

Human Research Ethics Committee

Principal Researcher:	Dr Carolyn Johnstone
Other/Student Researcher/s:	Katherine Christian Jo-ann Larkins
School/Section:	**School of Arts**
Project Number:	**A18-139**
Project Title:	**Challenges faced by early career researchers in the sciences in Australia and the consequent effect of those challenges on their careers: A mixed methods project.**
For the period:	04/12/2018 **to** 01/11/2022

Quote the Project No: A18-139 in all correspondence regarding this application.

Please note: External organisation approval/permission letters must be submitted to the HREC prior to commencement of recruitment at these organisations.

Approval has been granted to undertake this project in accordance with the proposal submitted for the period listed above.

Please note: It is the responsibility of the Principal Researcher to ensure the Ethics Officer is contacted immediately regarding any proposed change or any serious or unexpected adverse effect on participants during the life of this project.

In Addition: Maintaining Ethics Approval is contingent upon adherence to all Standard Conditions of Approval as listed on the final page of this notification

COMPLIANCE REPORTING DATES TO HREC:

Annual project report:
4 December 2019
4 December 2020
4 December 2021

Final project report:
1 December 2022
The combined annual/final report template is available at:

http://federation.edu.au/research/support-for-current-students-and-staff/ethics/human-ethics/human-ethics3

Fiona Koop
Coordinator Research Ethics
4 December 2018
Please note the standard conditions of approval on Page 2:

STANDARD CONDITIONS OF APPROVAL

1. Conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the HREC.

2. Advise (email: research.ethics@federation.edu.au) immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project.

3. Where approval has been given subject to the submission of copies of documents such as letters of support or approvals from third parties, these are to be provided to the Ethics Officer prior to research commencing at each relevant location.

4. Submission for approval of amendments to the approved project before implementing such changes. A combined amendment template covering the following is available on the HRE website: http://federation.edu.au/research/research-support/ethics/human-ethics/human-ethics3
   - Request for Amendments
   - Request for Extension. Note: Extensions cannot be granted retrospectively.
   - Changes to Personnel

5. Annual Progress reports on the anniversary of the approval date and a Final report within a month of completion of the project are to be submitted by the due date each year for the project to have continuing approval.

6. If, for any reason, the project does not proceed or is discontinued, advise the committee by completing the Final report form.

7. Notify the Ethics Officer of any changes in contact details including address, phone number and email address for any member of the research team.

8. The HREC may conduct random audits and / or require additional reports concerning the research project as part of the requirements for monitoring, as set out in the National statement on Ethical Conduct in Human Research.

Failure to comply with the National Statement on Ethical Conduct in Human Research (2007) and with the conditions of approval will result in suspension or withdrawal of approval.

Amendment Approval

Human Research Ethics Committee

Principal Researcher:	Dr Carolyn Johnstone
Other/Student Researcher/s:	Katherine Christian Jo-ann Larkins
School/Section:	**School of Arts**
Project Number:	**A18-139**
Project Title:	**Challenges faced by early career researchers in the sciences in Australia and the consequent effect of those challenges on their careers: A mixed methods project.**
For the period:	11/05/2020 **to** 01/11/2022

Quote the Project No. A18-139 in all correspondence regarding this application.

Amendment Summary: The project has added storage of data on the project's Microsoft Teams site.
Extension: N/A
Personnel: N/A

Please note: Approval has been granted to undertake this project in accordance with the proposal and amendments submitted for the period listed above. Ongoing ethics approval is contingent upon adherence to the Standard Conditions of Approval on Page 2 of this notification.

COMPLIANCE REPORTING TO HREC:

Annual project report:
4 December 2020
4 December 2021

Final project report:
1 December 2022

https://federation.edu.au/research/support-for-students-and-staff/ethics/human-ethics

Fiona Koop
Coordinator, Research Ethics
11 May 2020

Please note the standard conditions of approval on Page 2:

STANDARD CONDITIONS OF APPROVAL

1. Conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the HREC.

2. Advise (email: research.ethics@federation.edu.au) immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project.

3. Where approval has been given subject to the submission of copies of documents such as letters of support or approvals from third parties, these are to be provided to the Ethics Officer prior to research commencing at each relevant location.

4. Make submission for approval of amendments to the approved project before implementing such changes. A combined Amendment request template is available for the following:
   - Request for Amendments
   - Request for Extension. Note: Extensions cannot be granted retrospectively.
   - Changes to Personnel

5. Annual Progress reports on the anniversary of the approval date and a Final report within a month of completion of the project are to be submitted to the Ethics Officer by the due date each year for the project to have continuing approval.

6. If, for any reason, the project does not proceed or is discontinued, advise the committee by completing a Final report form.

7. Notify the Ethics Officer of any changes in contact details including address, phone number and email address for any member of the research team.

8. The HREC may conduct random audits and / or require additional reports concerning the research project.

Failure to comply with the National Statement on Ethical Conduct in Human Research (2007) and with the conditions of approval can result in suspension or withdrawal of approval.

Amendment Approval

Human Research Ethics Committee

Principal Researcher:	Dr Carolyn Johnstone
Other/Student Researcher/s:	Katherine Christian Jo-ann Larkins
School/Section:	**School of Arts**
Project Number:	**A18-139**
Project Title:	**Challenges faced by early career researchers in the sciences in Australia and the consequent effect of those challenges on their careers: A mixed methods project.**
For the period:	07/08/2020 **to** 01/11/2022

Quote the Project No. A18-139 in all correspondence regarding this application.

Amendment Summary: The placement of the project data on the Federation University-managed open data repository Federation.Figshare and make the project data available to other researchers.

Extension: N/A

Personnel: N/A

Please note: Approval has been granted to undertake this project in accordance with the proposal and amendments submitted for the period listed above. Ongoing ethics approval is contingent upon adherence to the Standard Conditions of Approval on Page 2 of this notification.

COMPLIANCE REPORTING TO HREC:

Annual project report:
4 December 2020
4 December 2021

Final project report:
1 December 2022

https://federation.edu.au/research/support-for-students-and-staff/ethics/human-ethics

Fiona Koop
Coordinator, Research Ethics
7 August 2020

Please note the standard conditions of approval on Page 2:

STANDARD CONDITIONS OF APPROVAL

1. Conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the HREC.

2. Advise (email: research.ethics@federation.edu.au) immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project.

3. Where approval has been given subject to the submission of copies of documents such as letters of support or approvals from third parties, these are to be provided to the Ethics Officer prior to research commencing at each relevant location.

4. Make submission for approval of amendments to the approved project before implementing such changes. A combined Amendment request template is available for the following:
   - Request for Amendments
   - Request for Extension. Note: Extensions cannot be granted retrospectively.
   - Changes to Personnel

5. Annual Progress reports on the anniversary of the approval date and a Final report within a month of completion of the project are to be submitted to the Ethics Officer by the due date each year for the project to have continuing approval.

6. If, for any reason, the project does not proceed or is discontinued, advise the committee by completing a Final report form.

7. Notify the Ethics Officer of any changes in contact details including address, phone number and email address for any member of the research team.

8. The HREC may conduct random audits and / or require additional reports concerning the research project.

Failure to comply with the National Statement on Ethical Conduct in Human Research (2007) and with the conditions of approval can result in suspension or withdrawal of approval.

Application for HREC Approval (Standard)

Human Research Ethics Committee

1. PROJECT DETAILS

Project title:

"Challenges faced by early career researchers in the sciences in Australia and the consequent effect of those challenges on their careers: a mixed methods project."

What type of project is this? (Tick as many as apply)

☐ Funded Consultancy	☐ Class Research Project	☐ Postgraduate Diploma
☐ Clinical Trial	☐ Undergraduate Research	☐ Masters by Research
☐ Staff Research Project	☐ Honours Research	☒ PhD
☐ Other	☐ Masters by Coursework	☐ Higher Doctorate

Through which School/Section is the research to be conducted?

School of Arts

What is your expected **completion** date? (Approval will be granted up until this date)

01/11/2022

Your project must not commence until **full** approval is granted.

2. RESEARCHERS

Principal Researcher (must be a STAFF MEMBER)	
Title & Name:	Dr Carolyn Johnstone
Position:	Associate Dean Teaching Quality
School/Section:	School of Arts
Phone number:	03 5327 9585
Email address:	c.johnstone@federation.edu.au
Academic qualifications:	PhD, MEd, MA, PGCE
Describe what this researcher will do in the context of this project:	Supervise the research and guide the student researcher. Ensure that the methodology selected is suitable to address the research questions. Support the analysis of data. Advise on working in the adult education sector and developing strategies for workplace learning programs.
Include a brief summary of relevant experience for this project:	Dr Johnstone has over 25 years of experience in developing government policy. She has conducted case study and narrative enquiry research and supervised one PhD and one Masters project.

Student/Other Researcher/s **copy and paste this table for each person involved in the project	
Title & Name:	Katherine Christian
Position:	HDR Student
School/Section:	School of Arts

Phone number:	0414 704 701
Email address:	katherinechristian@students.federation.edu.au
Student ID number:	30340876
Academic qualifications:	B Science Advanced Diploma of Management
Describe what this researcher will do in the context of this project:	The researcher will carry out a literature review on the topic. Informed by a focus group, the researcher will develop an online survey, which will be trialled with a sample of ECRs representative of the Australian STEMM research workforce before being deployed nationally. In tandem and following, she will hold semi-structured and freestyle interviews with ECRs. She may also interview some ECRs who have moved away from research. The researcher will collate and analyse the data and report results via a PhD thesis.
Include a brief summary of relevant experience for this project:	The researcher has spent a total of 19 years employed at Cure Cancer Australia (CCA). She also spent 8 years as Manager of the Research Division of Cancer Council NSW, an epidemiology unit, where she managed many research projects, including health and medical research surveys to gather data. Previously, she has worked as a market research analyst, where conducting interviews and surveys was part of her responsibility, and as a data collector and area manager for the Australian Census. In September 2018 KC completed the Australian Consortium for Social and Political Research Incorporated course “Foundations of Qualitative Methodologies, Data Collection & Analysis” in preparation for this research project.
Other Researcher/s	
Title & Name:	Jo-ann Larkins
Position:	Lecturer
School/Section:	School of Science, Engineering and IT
Phone number:	(03) 5122 8920
Email address:	Jo-ann.larkins@federation.edu.au
Student ID number:	
Academic qualifications:	BSc, GDEd
Describe what this researcher will do in the context of this project:	Research methodology expert with particular expertise in design and statistical analysis of survey based data. Advise and supervise all aspects of the survey(s) used in the research.
Include a brief summary of relevant experience for this project:	10+ years of experience with supporting a variety of research students (both HDR and undergraduate) in developing skills in quantitative research methodology including design research and analysis. J-AL will provide individualised support in understanding and using a variety of statistical software packages. She has a strong background in supporting the publication of research based around survey instruments across many disciplines (science, nursing and sociology).

3. LAY DESCRIPTION

Provide a brief outline of the project describing in everyday, jargon-free language the key aspects of the research (e.g., who will be participating, what information will be collected and by what means, what participants will be required to do, etc.) and the key research aims. The lay description must be in everyday, jargon-free language that is comprehensible by the average educated layperson. Define any technical terms or discipline-specific phrases, and use the full form of all acronyms the first time they are used. (**300 words max**.)

The research project will investigate the challenges faced by early-career researchers (ECRs) working in the sciences in Australia, against the background of insufficient funding and consequent lack of job security.

The literature demonstrates that there are many difficulties experienced by young researchers in the sciences internationally and in Australia, however information about the Australian environment is limited, and there is little evidence of steps taken to rectify these difficulties in Australia. The aim of the project is to explore and compare the views of ECRs to evaluate the factors which shape the ECR experience and contribute to job satisfaction or dissatisfaction and intention to leave, and perhaps define the features which are necessary to keep an ECR in research, providing recommendations for change.

Following an initial workshop and a pilot survey, an anonymous online survey will be conducted with ECRs working in universities and research institutions across Australia. Questions will address demographics, professional development opportunities, career planning and progression, facilities and working conditions available for parents and their families and gender imbalance. Further information will be gathered after the survey, if required, in interviews with ECRs and those who have recently left the research environment.

The data collected will be analysed thematically to compile overall results and to see if there are differences in responses from different groups.

4. RESEARCH AIMS & SIGNIFICANCE

State the aims, key research questions, and significance of the project. Where relevant, state the specific hypothesis to be tested. Also provide a brief description of the relevance of your proposed project to current research; (supported by a literature review and references) – refer to National Statement 1.1c, a justification as to why your research should proceed, including an explanation of any expected benefits to the community and its potential to contribute to existing knowledge. (**600 words max**.)

There is limited data about the workplace for ECRs in STEMM (Science, Technology, Engineering, Mathematics, Medicine) in Australia. Most research conducted in Australia has focused on lack of funding and its consequences. There has been little apparent effort to identify ways of improving the research workplace within the funding available. Research on job satisfaction of ECRs,

professional development or other workplace support for ECRs within the research environment is very limited.

The literature shows that in spite of our government's mandate to build the STEMM workforce, we continue to lose many ECRs, particularly women, out of research or, often, out of the country. (Bazeley et al. 1996);(Bell and Yates 2015); (Hardy 2015); (Hardy, Carter and Bowden 2016); (Meacham 2016), (NHMRC 2016)

Ways to solve the lack of funding is beyond the scope of this work. This project will provide evidence for the principal causes of job dissatisfaction, outside lack of funding, identifying realistic and achievable solutions to the problems.

The research questions to address the topic will be:

What are the relationships between ECR job satisfaction or dissatisfaction and their likelihood of staying in science?

a) What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?
b) What are the motivations for ECRs leaving the sciences?
c) What are the specific features of the experiences and environment of those ECRs who remain in the sciences?

The work will identify some realistic and achievable ways in which the environment for ECRs could be improved which could be considered by research institutions. Implementation of the recommendations will encourage well-prepared and supported ECRs to stay in research or take up alternative science-related careers in Australia. Specifically, the results of this work will influence and inform institutional management of ECRs by:

i) Providing knowledge about the contributors or barriers to job satisfaction for ECRs
ii) Providing understanding about reasons why ECRs leave the scientific environment of universities and research institutes in Australia or science altogether
iii) Identifying the specific features of the experience and environment of the researcher who stays, and
iv) Identifying what may help to overcome the challenges or provide ECR satisfaction in spite of them.

5. FUNDING & FINANCIAL BENEFITS

Researchers should include any source of funding (e.g., departmental, commercial, non-commercial, governmental) The HREC will consider whether there is a conflict of interest.

Are any of the researchers affiliated with or in receipt of any financial benefit from any of the external organisations involved in your research?	☒ Yes	☐ No

If **yes**, explain how, how much and for what purpose:

Katherine Christian is employed part time (0.4FTE) as Research Program Manager at Cure Cancer Australia

Has this protocol received research funding or is this submission being made as part of an application for research funding?	☐ Yes	☒ No
What is the status of the funding application? ☐ Approved ☐ Refused ☐ Pending		

If **yes**, what is the source of the funding?

What is the project grant title and proposed grant duration?

What is the registration number of the grant/funding application?

What is the deadline for the granting body?

Does this project require HREC approval before consideration for funding?	☐ Yes	☒ No

How will participants be informed of the source of the funding?

NA

6. MULTI CENTRE RESEARCH

Other HREC Approvals
The principal researcher is responsible for informing each HREC of all other sites at which the research is being proposed or conducted; disclosing to each HREC any previous decisions regarding the research made by another HREC; and informing each HREC of whether the protocol is presently before another HREC.

Is this protocol being submitted or has it been previously submitted to another Human Research Ethics Committee?	☐ Yes	☒ No

If **yes,** give details of other centres involved; the approval status of the study at each centre; and details of any required amendments.

7. EXTERNAL APPROVALS

If your research involves participants from other organisations (e.g. educational institutions, companies, agencies, collectives), you may need to obtain authorised approval before approaching participants, eg: Department of Education and Training, School Principals, School Councils (for research involving Government schools); Catholic Education Office (Catholic schools); School Boards (Independent schools); Senior Officers (Commercial or Government entities); Elders (Aboriginal communities); or Representative bodies (Collectives). Copies of approval letters must be attached to this application or, if pending at the time of submission, forwarded to HREC when

available. Some authorities may decline to provide permission letters until ethics approval has been granted. In such cases, you should submit your application to the HREC for provisional approval pending receipt of the documentation.

Does research involve or impact on participants from external agencies or organisations?	☒ Yes	☐ No
If **yes**, has required permission been obtained from relevant agencies?	☐ Yes	☒ No

If **yes,** please specify from whom and attach a copy

If **no**, specify from whom, and advise when this will be obtained

After HREC approval, the researcher will approach institutional heads to seek permission for their employees to participate in the focus group or interviews. Permission will also be sought from senior management to ask research office staff to distribute email invitations for the survey

8. RESEARCH METHODOLOGY

Provide an outline of the proposed method, including details of data collection techniques, tasks participants will be asked to complete, the estimated time commitment involved, and how data will be analysed. If the project includes any procedure that is already established and uses accepted techniques please include a description of the procedure. (**500 words max**).

The project will be mixed methods research consisting of qualitative research (focus group, interviews and reflective journal) and quantitative research (on-line surveys).

Focus Group
First, a focus group of ~10 ECRs from a variety of backgrounds will be invited to evaluate the draft survey questionnaire and provide feedback on whether all issues are covered. The focus group will be recorded and transcribed. Adjustments may be made to the questionnaire where appropriate.

Surveys
There are three surveys in this research.

Pilot Survey. ECRs (~10 respondents) will be surveyed on-line using LimeSurvey software. The email invitation will be sent with an embedded link to the survey. Responses will be collected in the University "cloud". Participants will be drawn from ECRs working in a range of STEMM disciplines and a variety of universities and research institutions in Sydney. Following analysis of responses to the questionnaire, the questions for the full on-line survey will be adjusted if necessary.

National On-Line Survey. The principal quantitative data collection will be a large-scale on-line survey for which ECRs in STEMM across Australia will be eligible. Organisations including, but not limited to EMCR Forum, Australian Society of Medical Research, Australian Academy of Science, Research Australia and university and institutional research offices will be asked to forward an email to potential participants with details of the research and a link to the on-line survey. Responses will be anonymous and the survey will take approximately 20 minutes to complete. At least 500 responses are expected. There is no need for institutions to select recipients apart from recipients being identified as people working in STEMM disciplines. The first questions will ascertain eligibility.

Follow-up Survey. A second survey will be conducted in conjunction with the national survey to optionally collect email addresses of respondents willing to be contacted for an in-depth interview or wishing to receive project results. Conducting these surveys in conjunction will not affect the anonymity of the national survey responses.

Reminder emails will be sent if required to achieve suitable numbers. Responses to surveys will be exported from LimeSurvey for analysis.

Interviews
Supporting the quantitative approach, a series of approximately 10 semi-structured in-depth interviews of about 30 minutes will be conducted with ECRs and former ECRs who have left the research environment who respond to the follow-up survey. Further freestyle interviews may be held with ECRs whom the researcher meets during the project, and who volunteer to share their views about the ECR experience. Consent will be obtained prior to all interviews, which will be recorded and transcribed. Interviews are most likely to be held in the interviewees place of work, or another independent environment

Journal
A reflective journal will be maintained throughout the life of the project.

Data Analysis
Survey data will be used to gather demographic information and broad scale responses across the ECR and supervisor populations. Data will be analysed using descriptive and inferential statistics using appropriate statistical software such as IBM SPSS or Minitab.

Responses to qualitative research will be coded for analysis. Results from quantitative and qualitative research will be compared and contrasted, using a thematic approach.

Is it likely / possible that any of the data collected may be used by you, or others, for any research other than that outlined in this application? See NS Chapter 2.2 and Chapter 3.2 when preparing your response.

☒ Yes	☐ No

If YES, describe below and ensure this is outlined in all Plain Language Information Sheets and Consent forms.

- Participants should be fully informed of the possibility of any future use of data collected and their 'extended' or 'unspecified' consent gained. Failure to do this may restrict the future use of the data.
- Any restrictions on the use of participants' data should be recorded and the record kept with the collected data. Restrictions must be accessible to researchers who want to access those data for research.

Questions in the survey will cover a broad range of topics which will be analysed for this project to provide "a big picture" of the research environment for ECRs. It may be of interest to researchers in the future, who may be researchers other than those on this project, to analyse some of these questions in depth, with a narrower view. This possibility is outlined in the plain language information sheets.

9. RECRUITMENT OF PARTICIPANTS

Participant Details

Describe your proposed recruitment strategy to source target participants. Provide the number and age range, giving a justification of your proposed sample size. Include details of statistical power of the sample where appropriate. To ensure the requirements for consent are met, refer to the National Statement Chapter 2.2 General requirements for consent:

Participants for the focus group (n=10) and the pilot survey (n=10) will be drawn from ECRs known to either Katherine Christian or members of the supervisory team and will be broadly representative of STEMM disciplines in Australia.

Focus group and pilot survey group participants will be different. For practical purposes, focus group participants will be drawn from Sydney institutions only.

It will be possible to recruit from a wider range of institutions for the pilot survey. These participants are likely to be people known to Katherine Christian or the supervisory team, or will be acquaintances of those acquaintances.

Focus group invitations will be emailed directly to participants from the researcher's university email address. The same email will be used to send a request to participate in the pilot survey, along with an embedded link to the on-line pilot survey.

Care will be taken to emphasise to acquaintances that there is no obligation to take part in either the focus group or the survey, pointing out that they must not feel under any pressure if they are unwilling, for any reason. It will also be explained that there are many ECRs who could be eligible for the focus group, so it will not be difficult to find the small number of participants required. Different version of the email invitations have been prepared for acquaintances.

Participants for the national on-line survey will be recruited through organisations including, but not limited to, Australian Society for Medical Research (ASMR), Australian Academy of Science, Research Australia and research offices within individual research institutions. These organisations will be invited to cascade an invitation email with an embedded link to the Limesurvey. Efforts will be made to ensure that the invitation is distributed widely across disciplines and institution types so that respondents encompass the STEMM disciplines in Australia.

In addition, social media will be used to raise awareness of the research and distribute the survey link. It is estimated that there are approximately 6,000 postdoctoral researchers in Australia, approximately 4,000 might be up to 10 years postdoctoral. In a survey conducted by EMCR Forum in 2014-15, it is reported the 284 respondents represented roughly 10% of the 3,000-member listserv used to recruit participants, and a number of participants likely found their way to the survey via social media or institutional emails. (Hardy et al. 2016). ASMR's 2015 survey (ASMR 2016) sent to 1,600 members (and advertised elsewhere) received 942 complete responses.
Participants will be invited to send the survey on to people they think might be similarly interested. It is noted that the use of this 'snowball selection' method, a non-random technique that provides access to difficult to reach or 'hidden' populations could result in bias either towards those who remain engaged with science or towards those who feel disenfranchised and may be motivated to complete such a questionnaire, even though they are likely to leave the field, however this is a precedent set by others.

Participants for interviews will be ECRs from a variety of STEMM disciplines and universities or research institutes in Australia. Participants for ECR interviews following the national survey will be selected from respondents who have chosen to make themselves available for further contact. Selection of these follow up respondents will be determined by the needs of the research. ECR interviews will include ECRs currently working in research environments and will include, for comparison, some who have left research in the past two years to pursue other careers. As so much of Katherine Christian's working life is spent within a range of research institutions and other scientific environments across Australia it is very likely that she will become aware of people who fit this category without difficulty, and without introducing bias to her sample. Assistance to identify suitable interviewees for this category will be sought from senior research office staff or from her supervisors should it be necessary to manage an appropriate balance.

Target participants
Who are the target participants? (Tick as many as applicable)

☒ Students or staff of this University
☒ Adults (over the age of 18 years and competent to give consent)
☐ Children/legal minors (under the age of 18 years, with parental consent)*
☐ Children in out of home care (under the age of 18 years – Note: Contact DHS for guidance in this area)
☐ Care Leavers – An adult who spent time in care as a child (under the age of 18) this could have been foster care, residential care, or other arrangements outside the immediate or extended family
☐ Women who are pregnant, Human Fetuses and Neonates
☐ Aboriginal and/or Torres Strait Island communities
☐ Other collectives where leader/council of elders may need to give consent
☐ Elderly individuals
☐ Individuals from non–English-speaking backgrounds
☐ People in other countries
☐ Pensioners or welfare recipients
☐ Intellectually or mentally impaired individuals unable/with compromised capacity to provide consent
☐ Individuals highly dependent on medical care with a compromised capacity to give consent
☐ Physically disabled individuals
☐ Patients or clients of professionals
☐ Prisoners, parolees
☐ People who may be involved in illegal activities

*Parental/Guardian consent may not be required in some instances - refer National Statement, 4.2.8 & 4.2.9

Proposed Recruitment Method
A copy of all recruitment materials used (e.g., printed advertisements, radio and television advertisement transcripts, posters, letters of invitation) must be attached to this application for review by the committee.

What is the proposed recruitment method? (Tick all that apply)
☐ Mail-out
☒ Email Have you attached a copy of the text of the email that will be sent? Yes ☒ No ☐ If **no**, please explain:
☐ Telephone
☐ Contact details obtained from public documents (e.g., phone book)
☒ Recruitment by researcher(s)
☐ Participants from a previous study
☒ Snowball (participants suggest other potential participants)
☒ Personal contacts – Provide details: People of Katherine Christian's acquaintance, via her work
☒ Other – please explain: Recruitment via LinkedIn or Twitter. Copy for social media attached.
☐ Advertisement (e.g. for a noticeboard or FedNews) Have you attached a copy of the advertisement? Yes ☒ No ☐ If no, please explain:
☒ Facebook Have you attached a copy of the advertisement that will be posted on Facebook? Yes ☒ No ☐ If **no,** please explain:
☒ Recruitment by a third party (e.g., employer, doctor) Have you attached a copy of the letter requesting their assistance, and/or the letter confirming their willingness to assist? Yes ☒ No ☐ If **no,** please explain:
☐ Private sources Have you attached a copy of the relevant approval letter? Yes ☐ No ☐ If **no**, please explain:

10. BURDENS OF RESEARCH (RISK & RISK MANAGEMENT)

This section raises the issue of your duty of care toward research participants. To what risks are participants subjected? What will you do should an emergency occur, or should a participant become upset or distressed? What is your risk management strategy?

Refer National Statement: Section 2.1 Risk and Benefit

Likely Benefits

Are participants likely to gain direct or indirect benefit from the research?	Yes ☒	No ☐

If **yes**, provide details

Recommendations made from this project will lead to improvements in the work environment for respondents and future researchers.

How will potential benefits to participants or community outweigh the risks?

There is a minimal risk of possible distress which could come about from thinking, writing or talking about difficulties encountered at work. An improved understanding of these difficulties which will lead to an improved work environment, however, is a greater benefit to the ECR community.

Research Activities

Which of the following activities will the research involve? (Tick as many as apply)

- ☒ Use of a questionnaire (attach copy)
- ☒ Interviews (attach interview questions)
- ☐ Observation of participants without their knowledge
- ☐ Participant observation
- ☒ Audio- or video-taping of interviewees or events
- ☐ Access to personal and/or confidential data (including student, patient or client data) without participants' specific consent
- ☐ Administration of any stimuli, tasks, investigations or procedures which may be experienced by participants as physically or mentally painful, stressful or unpleasant during or after the research process
- ☐ Performance of any acts which may diminish the self-esteem of participants or cause them to experience embarrassment, regret or depression
- ☐ Investigation of participants involved in illegal activities
- ☐ Procedures that involve deception of participants
- ☐ Administration of any substance or agent
- ☐ Use of non-treatment of placebo control conditions
- ☐ Collection of body tissues or fluid samples
- ☐ Collection and/or testing of DNA samples
- ☐ Participation in a clinical trial
  ☐ CTN Trial ☐ CTX Trial Please provide Phase number, i.e., either 1, 2, 3 or 4
- ☐ Testing a medical/diagnostic device

11. RISK MANAGEMENT PROCEDURES

Identify as far as possible all potential risks to participants (e.g. physical, psychological, social, legal, economic) associated with the proposed research. Explain what risk management procedures will be put in place. Any potential risks should be outlined in the Plain Language Information Statement (PLIS) along with contact details of an appropriately qualified organisation for participant reference in case of distress, eg: Lifeline

No adverse events are expected. Respondents might be caused to think about and identify difficulties they have or have had within their workplaces which could cause some distress. The Plain Language Information Sheet provides details for sources of assistance should any person be distressed as a consequence of this research.
The interviewer is familiar with the research environment and can also guide any distressed respondents to find appropriate support which is available within all the institutions and universities.

Where will the research be conducted? (Tick as many as apply)

☐ Federation University	☒ Other location(s)

If **other**, please give details (including the URL for web-based studies)

URL to come

Focus group at the offices of CCA, 422 Kent Street, Sydney.

Interviews will be conducted at the place of work of the interviewee or possibly at the offices of CCA, 422 Kent Street, Sydney or a suitable academic or otherwise independent environment.

Are facilities at the research location appropriate for the scientific needs of the research?	☒ Yes	☐ No

If **no**, please elaborate

Are the facilities appropriate to meet any physical, emotional or other needs of participants that result from their participation?	☒ Yes	☐ No

If **no,** please elaborate

Are there any specific risks to researchers?	☐ Yes	☒ No

If **yes,** please describe the risks identified, and your planned Risk Management protocol for researchers

What plans are in place to deal with adverse/unexpected outcomes?

Participants will be advised in the Plain Language Information Statement of the choice to opt out of the focus group, survey or interview at any time due to stress or any other factor. They will be provided with contact information for Lifeline (13 11 14) and advised to contact their General Practitioner (GP) if the distress or disturbances persist. In addition, the contact information for the Federation University Australia, Human Research Ethics Committee and Dr Carolyn

Johnstone, the PhD Supervisor, will be provided if participants wish to discuss further any concerns.

Will parts of this project be carried out by independent contractors?	Yes ☐	No ☒

If **yes,** please confirm that the independent contractor will receive from the first-named Principal Researcher, a copy of the approved ethics protocol and be made aware of their responsibilities arising from it.

If necessary, has the Principal Researcher ensured that the other researchers have undergone a police check and a Working With Children check?	Yes ☐	No ☐	N/A ☒

How will the conduct of the project be monitored to ensure that it conforms to the procedures set out in this application, the University's human ethics guidelines, the National Statement 5.5, and the Australian Code for the Responsible Conduct of Research 3.4? (In the case of student projects please give details of how the supervisor/s will monitor the conduct of the project; e.g., how often student and supervisor will meet; how meetings will be conducted: email/phone/in person; how efforts will be coordinated if a number of researchers are involved.)

The project will be monitored by the Principal Researcher and her colleagues associate-supervisors Ms Jo-ann Larkins, A/Prof Wendy Wright, and Dr Robert Watson, at their fortnightly Skype for Business meetings. They will review the research progress and ensure ethical procedures and guidelines are being followed.

Will there be support provided for participants? (You may need to consider having additional support for participants during or after the study, depending on risks to participants. Consider whether your project would require additional support and what support would be available.)

Participants will be provided with information to access the Lifeline helpline, and the PLIS will also advise them to contact their GP if distress continues. Furthermore, contact information for the Human Research Ethics Committee and Dr Carolyn Johnstone, the PhD Supervisor, will be provided.

What debriefing will participants receive following the study and when? (Attach a copy of any written material or statement to be used in such a debriefing. Participants may need to talk with the researchers about the experience of being involved in the study as well as learn more about the aims of the research.)

There is no de-briefing planned. Results of the project will be made available on request to all participants who have supplied contact details and to all interview participants. Results will also be made available in research papers and conference presentations. If the participants wish further information they will be invited to contact the PhD project supervisor, Dr Carolyn Johnstone. This information is provided on the Plain Language Information Statement.

12. INCENTIVES FOR PARTICIPATION

Note that while participants may, in certain circumstances, be paid or reimbursed for their inconvenience and time, the payment should not be of an amount that risks inducement to participate, thus potentially biasing the project's results. If rewards are to be used, all participants are to receive the reward.

Are financial or other rewards proposed to be given to participants?	☐ Yes	☒ No

If **yes**, describe how much and in what form the payment/incentive will take (e.g., money to reimburse travel costs, vouchers for movie tickets, chocolate frogs).

13. CONSENT

Dependent or Unequal Relationships
The consent of a person to participate in research must not be subject to any coercion. Research involving those in dependent or unequal relationships (e.g., teacher/student, manager/employee, parent/child, doctor/patient) may compromise a participant's ability to give consent that is free from any form of pressure (real or implied) arising from this unequal power relationship. The HREC therefore recommends that, where possible, researchers should choose participant cohorts where no dependent relationship exists. However, if the researcher believes that research involving people in dependent relationships is purposeful and methodologically defensible, the HREC will require additional information explaining why this is so and how any risks inherent in the dependent and unequal relationship will be managed. The HREC will also need evidence to show that participants have been reassured that refusal to participate will not result in any discrimination or penalty. Applicants should note that reasons of convenience will not normally be considered adequate justification for conducting research in situations where dependent relationships exist.

* Please refer to the National Statement on Ethical Conduct in Human Research – Chapter 4.3 for information on unequal relationships before answering the following question.

Does a dependent or unequal relationship exist between any participant and researcher, particularly those involved in recruiting?	Yes ☐	No ☒

If **yes**, please explain the relationship and the steps to be taken by the researchers to ensure that the participant's participation is purely voluntary and not influenced by the relationship in any way.

Please note the answer to the question is No. Nonetheless an explanation is provided. While there is an unequal relationship between the respondents and the institutions or staff within them, which are a focus of the survey, the institutions in question are not involved in the collection of this information other than by administrative staff distributing the project's "third party" email on behalf of the project via their mailing lists. The institutions will be supplied only aggregated results; there will be no information supplied to them which is specifically about their institution. All survey responses will be anonymous, although respondents may choose to name their institution. In addition, the researcher is employed by Cure Cancer Australia (CCA) which funds some of the participants' research. Funding agreements are held between Cancer Australia (a separate organisation) and the researchers' institutions and CCA has no influence on which researchers are selected for funding.

Informing Participants – Plain Language Information Statement (PLIS)

The potential participant must be provided with information at their level of comprehension about the purpose, methods, demands, risks, inconveniences, discomforts, and possible outcomes of the research (including the likelihood and form of publication of research results, and whether their data

may be made available for future research projects) so their consent is fully informed. Download the current template for the PLIS from the HREC website.

Have you attached a copy of the PLIS for participants?	☒ Yes	☐ No

If **no**, please explain

Does the PLIS comply with the following guidelines?	**YES**	**N/A**
It is presented on the Fed Uni HREC approved template, downloaded from the website	☒	*
It has clear identification of the University, the School(s) involved, the project title, the Principal and Other Researchers (including FedUni contact details).	☒	*
It details what involvement in the project will require (e.g., involvement in interviews, completion of questionnaire, audio/video-taping of events), estimated time commitment, any risks involved.	☒	*
It advises how participants' contact details were obtained and/or how potential participants were selected	☒	☐
If staff or students of the Federation University are to be involved as participants, it advises that the project has received clearance by the HREC	☒	☐
It advises that if the sample size is small this may have implications for privacy/anonymity.	☒	☐
It states clearly that if participants are in a dependent relationship with any of the researchers involvement in the project will not affect ongoing assessment, grades, employment, management or treatment of health (as relevant).	☐	☒
It states clearly that involvement in the project is voluntary and that participants are free to withdraw their consent to participate at any time, and to withdraw any unprocessed data previously supplied.	☒	*
It states that arrangements will be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations (e.g., subpoena, freedom of information claim, or mandatory reporting in some professions).	☒	☐
It advises whether or not data will be destroyed after a minimum period.	☒	☐
It advises the de-identified data collected may be used in future research projects	☒	☐
It provides any other relevant information.	☒	*

* Required

Obtaining and Documenting Consent

How will informed consent be obtained/recorded?
☒ Signed consent form – for focus group and interviews
☐ Recorded verbal consent
☒ Implied by return of survey – for survey *NB If consent is to be implied by return of survey, all information that would normally be presented on the consent form must be included in the PLIS
☐ Other (Please specify):

The correct template for the consent form can be found at:
http://federation.edu.au/research-and-innovation/research-support/ethics/human-ethics/human-ethics3

Is a copy of the consent form attached to this application form?	☒ Yes	☐ No

If **no,** please explain how consent will be documented:

Does the consent form comply with the following guidelines?
☒ It is presented on the Fed Uni HREC approved template, downloaded from the website
☒ It states the title of the project and names of the researchers
☒ It confirms that the project is for research
☒ It confirms that involvement in the project is voluntary and that participants are free to withdraw at any time or withdraw any unprocessed data previously supplied
☒ It details specific requirements of participants (e.g., interviews will be audio-/video-taped)
☒ It advises of any legal limitations to data confidentiality
☐ It advises that if the sample size is small this may have implications for privacy/anonymity
☒ It provides any other information relevant to obtaining participant consent

14. DISCONTINUING PARTICIPATION

Are participants advised as part of the informed consent process that they have the right to withdraw at any time or withdraw any unprocessed data previously supplied?	☒ Yes	☐ No

If **yes**, please detail how participants are informed of this right.

The freedom to withdraw from the study is stated in the Plain Language Information Statement. For those engaged in one-on-one interviews, this will involve the deletion of the recorded material. However, if participants withdraw during the course of the focus group, it will be impossible to disentangle their data. Likewise, it will be impossible to withdraw survey data once it has been submitted as responses are anonymous. All participants will be informed of the anonymity and/or confidentiality of their data.

If **no**, please explain why this advice has not been given

15. INFORMATION PROTECTION (DATA; STORAGE; SECURITY)

Confidentiality
Please give attention to implications for compliance with legislative requirements including, for example, Guidelines Approved under Section 95A of the Privacy Act 1988, produced by NHMRC, and Statutory Guidelines on Research Issued for the Purposes of Health Privacy Principles produced by the Office of the Health Services Commissioner.

What are Data? (NS Ch3.2 Databanks)
Data are pieces of information, eg:

- What people say in interviews, focus groups, questionnaires, personal histories and biographies;
- Analysis of existing information (clinical, social, observational or other);
- Information derived from human tissue such as blood, bone, muscle and urine.

(Note: Where the sample size is very small, or information is obtained through a focus group, it may be impossible to guarantee anonymity or confidentiality of participants' identity, and participants involved in such projects need to be advised of this limitation.) **Tick which method will be used to guarantee confidentiality/anonymity?**	
☐	**Individually identifiable data**, where the identity of a specific individual can reasonably be ascertained. Examples of identifiers include the individual's name, image, and date of birth or address.
☒	**Re-identifiable data**, from which identifiers have been removed and replaced by a code, but it remains possible to re-identify a specific individual by, for example, using the code or linking different data sets.
☒	**Non-identifiable (anonymous) data**, which have never been labelled with individual identifiers or from which identifiers have been permanently removed, and by means of which no specific individual can be identified. A subset of non-identifiable data are those that can be linked with other data so it can be known that they are about the same data subject, although the person's identity remains unknown.

Tick all that apply from the boxes below:

☐	Participants will have the option of being identified in publications arising from the research.
☒	Participants will be referred to by pseudonym in publications arising from the research.
☐	Personal information will be obtained from a Commonwealth department or agency? (If **yes**, you may need to comply with the requirements of the Privacy Act 1988).
☐	Any other method of protecting the privacy of participants (e.g., use of direct quotes with specific, written permission only; use of real name with specific, written permission only). **Please describe:**

Security and Storage

Does the Principal Researcher accept responsibility for the security of the data collected?	☒ Yes

Who will have access to data?	
☐ Access by named researchers only	☒ Access by other(s) than named researcher(s)

If others have access to data, identify who, at which storage site, for what purpose, and their connection to the project.

Access by named researchers and the remainder of the supervisory team, A/Prof Wendy Wright and Dr Rob Watson.

Which of the following methods will be used to ensure data security?
☒ Data will be kept in locked filing cabinets
☐ Data and identifiers will be kept in separate, locked filing cabinets
☒ Access to computer files will be available by password only

☒ Other (please describe) The audio tapes from the focus group and interviews will be deleted once uploaded to a computer or transcribed. The transcriptions of the tapes will be stored in a password protected file on a computer and this will be deleted from both the folder and the recycle box five years after the conclusion of the project.

Does data storage comply with the NHMRC/ARC Australian Code for the Responsible Conduct of Research? See Section 2: Management of research data and primary materials	☒ Yes	☐ No

If **no,** please explain

Please confirm that at the conclusion of the study, the data will be kept in locked facilities in the School through which the project is being conducted	☒ Yes

If data is to be kept elsewhere during fieldwork, please explain how and where data will be held, including arrangements for data security

Recordings from the focus group or interviews will be held in locked facilities until the digital files can be transferred to a password protected computer.

Please confirm that any data collected will be kept for a **minimum** of 5 years from date of research publication.	☒ Yes

Will the data be destroyed at some point **after** being kept for the minimum 5 year period? (Data may be kept indefinitely, but must be appropriately secured)	☒ Yes	☐ No

If **yes**, how and when will data be disposed of?

Five years after the project concludes, the Principal Researcher will dispose of all digital files containing data.	☒ Yes

16. DISSEMINATION OF RESULTS

Explain when, how, where and to whom results will be disseminated, including whether participants will be provided with information on the project's findings or outcomes.

The results of this study will be submitted for publication in peer-reviewed journals and a conference presentation(s).

How will results be made available to **participants**? (Tick as many as apply)
☒ Written summary of results
☐ Copy of final manuscript (thesis, article, etc.)
☐ Verbal presentation (info session, debriefing, etc.)
☐ Presented to all participants

☒ Presented if requested
☐ Presented to representative participants (e.g. CEO, school principal)
☐ Other - Please explain:
☐ None - Please explain:

How will results be made available to **peers and colleagues**: Tick as many as apply	
☒ Conference papers	☒ Journal article(s)
☒ Thesis	☐ Book
☐ Other - Please explain	☐ None - Please explain

17. LEGAL ISSUES

Does the project involve subject matter or conduct that may give rise to legal vulnerability of participants or researchers?	☐ Yes	☒ No

If **yes**, please give details

Are adequate precautions to be taken?	☐ Yes	☐ No	☒ N/A

If **yes,** please give details

Confidentiality of information provided can only be protected within the limitations of the law. Depending on the research proposal, you may need to state these limitations specifically (subpoena, freedom of information claim, mandated reporting by some professions, etc.) Have you included appropriate information on the legal limitations of protecting confidentiality in the PLIS and consent form?	☐ Yes	☐ No	☒ N/A

If **no**, please advise how participants will be advised

18. CHECKLIST OF ATTACHMENTS

Please check that the following documents are attached to your application. Applicants should note that where questionnaire or interview questions are submitted in draft form, a copy of the final documentation must be submitted for final approval when available.

Are the following documents attached?	**Yes**	**No**	**N/A**
Recruitment advertisement (e.g. for noticeboard or FedNews)	☒	☐	☐

Plain Language Information Statement	☒ (3 versions)	☐	*
Consent form	☒	☐	☐
Evidence of external approvals related to the research	☐ ☒ Pending	☐	☐
Questionnaire	☒ ☐ Draft	☐	☐
Interview Schedule – will be drawn up later in the research period after survey responses are analysed	☐ ☐ Draft	☒	☐
Debriefing material	☐	☒	☐
Other	☐	☐	☒

*** Required**

19. DECLARATIONS

Researcher Declarations:

The information contained herein is, to the best of my knowledge and belief, accurate. I have read the University's current human ethics guidelines, and accept responsibility for the conduct of the procedures set out in the attached application in accordance with the guidelines, the Australian Government's National Statement on Ethical Conduct in Human Research 2007 (Updated May 2015), The Australian Code for the responsible Conduct of Research, and any other condition laid down by the Federation University's Human Research Ethics Committee or its sub-committees. I have attempted to identify all risks related to the research that may arise in conducting this research and acknowledge my obligations and the rights of the participants. I and my co-researchers and supporting staff have the appropriate qualifications, experience and facilities to conduct the research set out in the attached application and to deal with any emergencies and contingencies related to the research that may arise.

……. …….. Principal Researcher ……CAROLYN JOHNSTONE …… (Print name in block letters) Date: 12./ 11 ../ 2018 ...	
…. …. Other Researcher …KATHERINE CHRISTIAN… (Print name in block letters) Date: …12/11/2018....	……. ……. Other Researcher …JO-ANN LARKINS (Print name in block letters) Date: ...12/11/2018...
…… Other Researcher …… (Print name in block letters) Date: ……./……../……..	…… Other Researcher …… (Print name in block letters) Date: ……./……../……..
…… Other Researcher …… (Print name in block letters)	…… Other Researcher …… (Print name in block letters)

Date: ……./……../……..	Date: ……./……../……..

*NB: If the following section is not completed, the application will not be accepted for review.

Declaration by authorised signatory:
Head of School, Deputy Head of School, Associate Dean Research, or Ethics Coordinator (Mt Helen campus only)

I have reviewed this project and consider the methodological/technical aspects of the proposal to be appropriate to the tasks proposed and recommend its approval. I consider the Researcher(s) to have the necessary qualifications, experience and facilities to conduct the research proposed and to deal with any emergencies and contingencies that may arise.
Comments/Provisos
Signature: …….. Signatory Name:…….. ☐ Head of School or ☐ Deputy Head of School or ☐ Associate Dean of Research or ☐ Faculty Ethics Coordinator Date ……../……../……

References
ASMR. 2016. The 2016 ASMR Health and Medical Research Workforce Survey. Australian Society of Medical Research.
Bazeley, P., L. Kemp, K. Stevens, C. Asmar, C. Grbich, H. Marsh, R. Bhathal, A. R. C. (ARC) & E. a. T. A. N. National Board of Employment. 1996. Waiting in the Wings: A Study of Early Career Academic Researchers in Australia. Australian Research Council.

Bell, S. & L. Yates. 2015. Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne.
Hardy, M. C. 2015. Early-career researchers the missing link for STEM diversity. The Conversation.
Hardy, M. C., A. Carter & N. Bowden (2016) What do postdocs need to succeed? A survey of current standing and future directions for Australian researchers. 2, 16093.
Meacham, S. 2016. The 2016 ASMR Health and Medical Research Workforce Survey. Australian Society of Medical Research.
NHMRC. 2016. Consultation Paper Structural Review. NHMRC.

Appendix 1: Plain Language Information Statement (PLIS) Focus group – to be amended

PROJECT TITLE:	**Challenges faced by early-career researchers in the sciences in Australia**
PRINCIPAL RESEARCHER:	**Dr Carolyn Johnstone**
OTHER/STUDENT RESEARCHERS:	**Jo-ann Larkins, Co-Supervisor and Statistician Katherine Christian**

This research is being conducted as part of a PhD project undertaken by- Katherine Christian, a research student in the School of Arts at Federation University Australia. The purpose of this research is to gather data about worklife experiences for early-career researchers (ECRs) in the sciences in Australia. It is expected that the results will inform recommendations for changes to the work environment for these researchers in order to increase their job satisfaction and the likelihood of them continuing to work in science in Australia.

This study has received approval from Federation University Australia's Human Research Ethics Committee.

Some data for the project will be collected in an on-line survey. All ECRs up to ten years post-doctoral, working in a universities and research institutes in the sciences in Australia, are eligible to take part. In conjunction, there will be some follow up interviews with ECRs and ECRs who have recently left research.

Should you wish to participate in this study, you are requested to participate in a focus group to discuss the questionnaire. The questions asked will be about your views about whether the questionnaire adequately captures the factors contributing to the ECR experience, what impact these factors have on them and their job satisfaction and intention to leave, and what is or could be done to address them. It is anticipated that this focus group will take about 60 minutes of your time.

Participation in this study is purely voluntary, and you have the right to withdraw your consent to participate or discontinue your participation in the focus group at any time without explanation by simply informing us. We will audio record the interview but will not ask for any identifying information for you or your institution on these recordings or at any other time. If per chance names are mentioned inadvertently, we will later replace these in the transcribed version with pseudonyms. Once the tapes have been transcribed, the audio recordings will be deleted.

Your responses to the questions will form part of a larger database, from which only group data will be reported. Only the researchers listed above will have access to the data. Any publications that arise from this study will report only group not individual data. Please note that by completing the consent form you are deemed to have given your informed consent to participate in this study.

It is possible that, in the future, data collected from this study might be made available for more detailed research about specific factors. The researchers might be different from the current researchers, however the data which would be made available is the anonymous data. The future study or studies would be subject to their own ethics application.

It may be that in discussing these issues you will experience discomfort or distress; in this event, you are free to leave the focus group. There are no specific risks associated with this study, however, if you experience any distress as a result of the questions asked, contact Lifeline (13 11 14) or Beyond Blue (1300 224 636) to discuss your issues. If any distress persists, it is recommended that you contact a

General Practitioner. For staff of Federation University Australia, you may contact the Federation University Australia Counselling Service (Ballarat/Wimmera (03) 5327 9470; Gippsland/Berwick (03) 5122 6425).

Results will be disseminated by publication of Katherine Christian's PhD thesis, and in academic journals or at conference presentations. A summary of the results of this study will be available in about 2022. If you would like a copy of the results, please email Dr Carolyn Johnstone and the information will be forwarded to you.

Thank you for considering participation in this research.

If you have any questions, or you would like further information regarding the project titled "Challenges faced by early-career researchers in the sciences in Australia" please contact the Principal Researcher, Dr Carolyn Johnstone of the School of Arts EMAIL: c.johnstone@federation.edu.au PH: 03 5327 9585
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

Appendix 2: Plain Language Information Statement (PLIS) Interview –to be amended

PROJECT TITLE:	**Challenges faced by early-career researchers in the sciences in Australia**
PRINCIPAL RESEARCHER:	**Dr Carolyn Johnstone**
OTHER/STUDENT RESEARCHERS:	**Jo-ann Larkins, Co- Supervisor and Statistician** **Katherine Christian**

This research is being conducted as part of a PhD project for Katherine Christian, a research student at Federation University Australia. The purpose of this research is to gather data about worklife experiences for early-career researchers in the sciences in Australia. It is expected that the results will inform recommendations for changes to the work environment for these researchers in order to increase their job satisfaction and the likelihood of them continuing to work in science in Australia.

This study has received approval from Federation University Australia's Human Research Ethics Committee.

Some data for the project will be collected in an on-line survey. All ECRs up to ten years post-doctoral, working in a research environment in the sciences in universities and independent research institutes, are eligible to take part. In conjunction, there will be some follow up interviews with ECRs and ECRs who have recently left research.

Should you wish to participate in this study, you are requested to participate in a one-on-one interview. The questions asked will be about your views about factors which contribute to the ECR experience, what impact these factors have on them, and on their job satisfaction or dissatisfaction and consequent intention to leave the research environment. It is anticipated that this interview will take about 30 minutes of your time.

Participation in this study is purely voluntary, and you have the right to withdraw your consent to participate or discontinue the interview at any time without explanation by simply informing us. We will audio record the interview but will not ask for any identifying information for you or your institution on this tape or at any other time. If per chance names are mentioned inadvertently, we will later replace these in the transcribed version with pseudonyms. Once the tape has been transcribed, the audio recordings will be deleted.

Your responses to the questions will form part of a larger database, from which only group data will be reported. Only the researchers listed above, and the supervisory team, will have access to the anonymous data. Any publications that arise from this study will be report only group not individual data. Please note, that by consenting to the interview you are deemed to have given your informed consent to participate in this study.

It is possible that, in the future, data collected from this study might be made available for more detailed research about specific factors. The researchers might be different from the current researchers, however the data which would be made available is the anonymous data. The future study or studies would be subject to their own ethics application.

It may be that in discussing these issues you will experience discomfort or distress and we will cease the interview. There are no specific risks associated with this study, however, if you experience any distress as a result of the questions asked, contact Lifeline (13 11 14) or Beyond Blue (1300 224 636) to discuss your issues. If any distress persists, it is recommended that you contact a General Practitioner.

For staff of Federation University Australia, you may contact the Federation University Australia Counselling Service (Ballarat/Wimmera (03) 5327 9470; Gippsland/Berwick (03) 5122 6425).

Results will be disseminated by publication of Katherine Christian's PhD thesis, and in academic journals or at conference presentations. A summary of the results of this study will be available in about 2022. If you would like a copy of the results, please email Dr Carolyn Johnstone and the information will be forwarded to you.

Thank you for considering participation in this research.

If you have any questions, or you would like further information regarding the project titled "Challenges faced by early-career researchers in the sciences in Australia" please contact the Principal Researcher, Dr Carolyn Johnstone of the School of Arts EMAIL: c.johnstone@federation.edu.au PH: 03 5327 9585
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

Appendix 3: Plain Language Information Statement (PLIS) Survey to be amended

PROJECT TITLE:	**Challenges faced by early-career researchers in the sciences in Australia**
PRINCIPAL RESEARCHER:	**Dr Carolyn Johnstone**
OTHER/STUDENT RESEARCHERS:	**Jo-ann Larkins, Co-Supervisor and Statistician** **Katherine Christian**

This research is being conducted as part of a PhD project for Katherine Christian, a research student at Federation University Australia. The purpose of this research is to gather data about worklife experiences for early-career researchers in the sciences in Australia. It is expected that the results will inform recommendations for changes to the work environment for these researchers in order to increase their job satisfaction and the likelihood of them continuing to work in science in Australia.

This study has received approval from Federation University Australia's Human Research Ethics Committee.

Some data for the project will be collected in an on-line survey. All ECRs up to ten years post-doctoral, working in a research environment in the sciences in universities and independent research institutes, are eligible to take part. In conjunction, there will be a series of follow up interviews with ECRs and ECRs who have recently left research.

Should you wish to participate in this study, you are requested to participate in the on-line survey. The questions asked will be about the challenges faced by early-career researchers and what impact these challenges have on them, and what is or could be done to address them. You will also be asked to provide basic demographic information of age and gender. It is anticipated that this survey will take about 20 minutes of your time.

Participation in this study is purely voluntary, and you have the right to withdraw your consent to participate or discontinue the survey at any time without penalty by closing your web browser. Please note, that because this study is anonymous, once you have submitted the survey it will not be possible to identify and remove your data. Submission of the completed survey is deemed to be your informed consent to participate in the study.

Your responses to the questions will form part of a larger database, from which only group data will be reported. Only the researchers listed above, and the supervisory team, will have access to the anonymous data. Any publications that arise from this study will be report only group not individual data. Please note, that by taking part in the survey you are deemed to have given your informed consent to participate in this study.

In conjunction with this survey you will be invited to take part in a second, optional, survey conducted in parallel. This second survey will optionally collect your email address if you are willing to be contacted for an in-depth interview or if you wish to receive project results. Conducting these surveys in conjunction will not affect the anonymity of the main survey responses.

It is possible that, in the future, data collected from this study might be made available for more detailed research about specific factors. The researchers might be different from the current researchers, however the data which would be made available is the anonymous data. The future study or studies would be subject to their own ethics application.

It may be that in responding to the survey you will experience discomfort or distress; in this event, you are free to log out of the survey. There are no specific risks associated with this study, however, if you experience any distress as a result of the questions asked, contact Lifeline (13 11 14) or Beyond Blue (1300 224 636) to discuss your issues. If any distress persists, it is recommended that you contact a General Practitioner. For staff of Federation University Australia, you may contact the Federation University Australia Counselling Service (Ballarat/Wimmera (03) 5327 9470; Gippsland/Berwick (03) 5122 6425).

Results will be disseminated by publication of Katherine Christian's PhD thesis, and in academic journals or at conference presentations. A summary of the results of this study will be available in about 2020. If you would like a copy of the results, please email Dr Carolyn Johnstone and the information will be forwarded to you.

Thank you for considering participation in this research.

If you have any questions, or you would like further information regarding the project titled "Challenges faced by early-career researchers in the sciences in Australia" please contact the Principal Researcher, Dr Carolyn Johnstone of the School of Arts EMAIL: c.johnstone@federation.edu.au PH: 03 5327 9585
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

Appendix 4: Email Invitation for Survey

Email Header: Survey about Challenges faced by early-career researchers in STEMM in Australia

Dear First Name

This email is sent on behalf of Katherine Christian who is currently undertaking a PhD at Federation University Australia and is conducting a research project exploring challenges faced by early-career researchers (ECRs) in the sciences in Australia. This research has approval from the Federation University Australia Human Research Ethics Committee. It is expected that the results will inform recommendations for changes to the work environment for these researchers in order to increase their job satisfaction and the likelihood of them continuing to work in science in Australia.

We would like to invite **ECRs** to participate in this project by completing an online questionnaire.

The online questionnaire is completely anonymous, participation is voluntary, and you can withdraw at any time without explanation by closing your web browser. The questionnaire can be completed at a time that is convenient to you, and it is expected that it should take approximately 20 minutes to complete.

To participate in the study please go to: [insert LimeSurvey project questionnaire link here]

Please consider passing this invitation on to other ECRs working in universities or research institutes in the sciences in Australia.

This project is being conducted under the supervision of Dr Carolyn Johnstone (Federation University Australia: School of Arts) and Ms Jo-ann Larkins (School of Science, Engineering and IT). For more information regarding the study, please contact Dr Johnstone on 03 5327 9585 or c.johnstone@federation.edu.au.

Thank you for considering taking part in this research.

Appendix 5: Social media Invitation for Survey

Survey about “Challenges faced by early-career researchers in STEMM in Australia”

I am currently undertaking a PhD at Federation University Australia and conducting a research project exploring challenges faced by early-career researchers (ECRs) in STEMM in Australia. It is expected that the results will inform recommendations for changes to the work environment for these researchers in order to increase their job satisfaction and the likelihood of them continuing to work in science in Australia. This research has approval from the Federation University Australia Human Research Ethics Committee.

We would like to invite **ECRs** working in the sciences in universities and research institutes in the sciences in Australia to participate in this project by completing an online questionnaire.

The online questionnaire is completely anonymous, participation is voluntary, and you can withdraw at any time without explanation by closing your web browser. The questionnaire can be completed at a time that is convenient to you, and it is expected that it should take approximately 20 minutes to complete.

To participate in the study please go to: [insert LimeSurvey project questionnaire link here]

Please consider sharing this invitation with other ECRs working in the sciences in Australia.

This project is being conducted under the supervision of Dr Carolyn Johnstone (Federation University Australia: School of Arts) and Ms Jo-ann Larkins (School of Science, Engineering and IT). For more information regarding the study, please contact Dr Johnstone on 03 5327 9585.

Thank you for considering taking part in this research.

Appendix 6: Federation University Australia Staff Advertisement

Project Title: Challenges faced by early-career researchers in the sciences in Australia

Chief Investigator: Dr Carolyn Johnstone

Other investigators: Jo-ann Larkins; Katherine Christian

Study Description

The aim of this research project is to explore challenges faced by early-career researchers in the sciences in Australia. It is expected that the results will inform recommendations for changes to the work environment for these researchers in order to increase their job satisfaction and the likelihood of them continuing to work in science in Australia. This research has approval from the Federation University Australia Human Research Ethics Committee.

Participants should be ECRs working in universities or research institutes in the sciences in Australia. Some data for the project will be collected in an on-line survey. In conjunction, there will be a series of follow up interviews with ECRs and ECRs who have recently left research.

This project is being conducted under the supervision of Dr Carolyn Johnstone (Federation University Australia: School of Arts) and Ms Jo-ann Larkins (School of Science, Engineering and IT). For more information regarding the study, please contact Dr Johnstone on 03 5327 9585.

Thank you for considering taking part in this research.

Please consider passing this invitation on to other ECRs working in the sciences in Australia.

Appendix 7: **Consent Form for Interview or Focus Group**

PROJECT TITLE:	**Challenges faced by early-career researchers in the sciences in Australia**
PRINCIPAL RESEARCHER:	**Dr Carolyn Johnstone**
OTHER/STUDENT RESEARCHERS:	**Jo-ann Larkins, Co-Supervisor and Statistician** **Katherine Christian**

Code name allocated to the participant:	

Consent – Please complete the following information:

I _____ of

_____+

hereby consent to participate as a subject in the above research study.

The research program in which I am being asked to participate has been explained fully to me, verbally and in writing, and any matters on which I have sought information have been answered to my satisfaction.

I understand that: all information I provide including digital audio recorded interviews and focus groups will be treated with the strictest confidence (subject to legal limitations) and data will be stored separately from any listing that includes my name and address.

- Aggregated results will be used for research purposes and may be reported in scientific and academic journals.
- I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and information/data obtained from it will not be used.
- I understand the exception to this is if I withdraw after information has been aggregated - it is unable to be individually identified - so from this point it is not possible to withdraw my information/data, although I may still withdraw my consent to participate.

SIGNATURE:_____ **DATE:** _____.

_____

SIGNATURE:_____ **DATE**:_____

If you have any questions, or you would like further information regarding the project titled "Challenges faced by early-career researchers in the sciences in Australia" please contact the Principal Researcher, Dr Carolyn Johnstone of the School of Arts EMAIL: c.johnstone@federation.edu.au PH: 03 5327 9585
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

Appendix 8 Interview Questions

Participants will be thanked for their participation and will be asked to provide background as specified below. These data will be recorded anonymously on a data sheet separate from the audio recordings of interviews and focus groups.

ECR Interviews

Background for ECRs

- How many years post doc?
- Age
- Discipline
- Workplace

Background for ECRs who have recently left research

- How many years post doc?
- Age
- Discipline
- Current workplace or work type
- Time since left university or research institute

Questions

ECR interview questions will be determined by the survey results and will seek in depth information about the major factors contributing to the ECR experience, job satisfaction and intention to leave which emerge from the data.

Appendix 9: Letter or email to Senior Staff at University or Research Institute

Project Title: Challenges faced by early-career researchers in the sciences in Australia

Chief Investigator: Dr Carolyn Johnstone

Other investigators: Jo-ann Larkins; Katherine Christian

Study Description

The aim of this research project is to explore challenges faced by early-career researchers (ECRs) in the sciences in Australia. It is expected that the results will inform recommendations for changes to the work environment for these researchers in order to increase their job satisfaction and the likelihood of them continuing to work in science in Australia.

Participants should be **ECRs** working in universities or research institutes in the sciences in Australia. The online questionnaire is completely anonymous, and participation is voluntary. Data collected in interviews will be anonymized and will form part of a larger database, from which only group data will be reported.

I write to ask your permission to invite ECRs at your institution to take part in the research.

I also ask permission to request that your research office or human resources department send out the email invitation on behalf of the project. There is no need to select recipients beyond identifying whether they work in STEMM disciplines.

This research has approval from the Federation University Australia Human Research Ethics Committee. This project is being conducted under the supervision of Dr Carolyn Johnstone (Federation University Australia: School of Arts) and Ms Jo-ann Larkins (School of Science, Engineering and IT). For more information regarding the study, please contact Dr Johnstone on 03 5327 9585.

Thank you for considering support of this research. Please reply to this request by an email to katherinechristian@students.federation.edu.au

---

Please see separate document for Appendix 10 Survey questions

Annual/Final Project Report

Human Research Ethics Committee

Please indicate the type of report	☐ Annual Report (**Omit 3b & 5b**) ☒ Final Report
Project No:	18-139
Project Name:	Challenges faced by early career researchers in the sciences
Principal Researcher:	Dr Carolyn Johnstone
Other Researchers:	A/Prof Wendy Wright, Jo-ann Larkins, Katherine Christian
Date of Original Approval:	4/12/2018
School / Section:	School of Arts
Phone:	03 5327 9585
Email:	c.johnstone@federation.edu.au

Please note: For HDR candidates, this Ethics annual report is a separate requirement, in addition to your HDR Candidature annual report, which is submitted mid-year to research.degrees@federation.edu.au.

1) Please indicate the current status of the project:				
1a) Yet to start				☐
1b) Continuing				☐
1c) Data collection completed				☒
1d) Abandoned / Withdrawn:				☐
1e) If the approval was subject to certain conditions, have these conditions been met? (If not, please give details in the comments box below)			☒ Yes	☐ No
Comments: Approval had to be sought from each institution prior to contact with potential participants. These approvals were obtained and forwarded to the HREC				
1f) Data Analysis	☐ Not yet commenced	☐ Proceeding	☒ Complete	☐ None
1g) Have ethical problems been encountered in any of the following areas: **Study Design**			☐ Yes	☒ No

Annual/Final Project Report

Human Research Ethics Committee

Recruitment of Subjects **Finance** **Facilities, Equipment** **(If yes, please give details in the comments box below)**	☐ Yes ☐ Yes ☐ Yes	☒ No ☒ No ☒ No
Comments:		

2a) Have amendments been made to the originally approved project?	
☐ No	☒ Yes
2b) If yes, was HREC approval granted for these changes?	
☒ Yes	**Provide detail:** ☒ Yes **Application for Amendment to an Existing Project** ☐ Yes **Change of Personnel** ☐ Yes **Extension Request**
☐ No	**If you have made changes, but not had HREC approval, provide detail as to why this has not yet occurred:**
2c) Do you need to submit any amendments now?	
☒ No	☐ Yes **Application for Amendment to an Existing Project** ☐ Yes **Change of Personnel** ☐ Yes **Extension Request** *** NB: If 'Yes', download & submit the appropriate request to the HREC for approval:** **Please note: Extensions will not be granted retrospectively. Apply well prior to the project end date, to ensure continuity of HRE approval.**

3a) Please indicate where you are storing the data collected during the course of this project: (Australian code for the Responsible conduct of Research Ch 2.2.2, 2.5 – 2.7)
On password protected computers, on Federation One Drive and on Federation.figshare (subject to embargo and with HREC approval)
3b) Final Reports: Advise when & how stored data will be destroyed (Australian code for the Responsible conduct of Research Ch 2.1.1)
The recordings of the interviews and focus group discussion were destroyed after they were transcribed. The remaining data will not be destroyed but will remain on Federation.figshare as per

approval. Stored data on personal computers will be destroyed once planned publications are complete. Contact details for those study participants who chose to leave them will be retained on KC's password protected computer and One Drive until decisions regarding any follow up work have been made.

4) Have there been any events that might have had an adverse effect on the research participants OR unforeseen events that might affect continued ethical acceptability of the project?

☒ No	☐ Yes *** NB: If 'yes', please provide details in the comments box below:**

Comments:

5a) Please provide a short summary of results of the project so far (no attachments please):

The purpose of the study was to explore the challenges faced by early-career researchers (ECRs) in the sciences in Australia and the consequent effect of those challenges on their careers. Using a realist/postpositivist paradigm, an evaluative approach, and a framework of job satisfaction, this project has explored and compared the views of ECRs to evaluate the factors which shape the ECR experience and contribute to job satisfaction or dissatisfaction and intention to leave, and perhaps define the features which are necessary to keep an ECR in research.

Data collection for this mixed methods study entailed a national survey of researchers working in universities and research institutes (n=658), a focus group discussion and eight semi-structured in-depth interviews with women from a variety of disciplines who had recently left academic research workplaces. I focussed particularly on the difficulties consequent to job insecurity: the constant need to attracting funding and a permanent position, lack of work-life balance and associated stress; and evidence of workplace difficulties such as bullying, harassment or inequity and support – or lack of it – offered by the research institutions. I examined the factors which contribute to and barriers which prevent job satisfaction of this population, and the consequent intention (if any) for ECRs to leave research or change their career path.

I found an interesting situation whereby the satisfaction derived from a "love of science" was counterbalanced by stress and poor working conditions which are a consequence of lack of job insecurity, typified by poor supervision, bullying or harassment, inequitable hiring practices, a concerning rate of impact from "questionable research practices" (34%-41%) and evidence of very high (80%) intention of ECRs to leave their position. The most significant predictor of intention to leave is time as a postdoctoral scientist: eventually the job insecurity and its associated stresses become too much and the ECRs leave their chosen career for work elsewhere. This decision, too, provides interesting findings as many of the ECRs have difficulty planning what to do next. They feel ill-prepared for an alternate career and suffer from a sense of failure as a result of having to

leave academia.

While addressing the shortage of funding is outside the scope of this study, in addition to offering my findings I put forward a range of recommendations which could lead to a change of culture and benefit the wellbeing of ECRs in STEMM without incurring significant cost.

The Australian Government, higher education institutions and the research community need to improve job security and workplace conditions and take better care of our people in STEMM disciplines or we will not have the scientists we need to deliver the "innovative Australia" planned for 2030 (Department of Industry Innovation and Science, 2018).

5b) Final Reports: Provide details about how the aims of the project, as stated in the application for approval, were achieved (or not achieved).
(Australian code for the Responsible conduct of Research 4.4.1)

The aims of the project have been achieved as the answers to the research questions, listed below, have been answered within the thesis:

- What are the relationships between ECR job satisfaction or dissatisfaction and their likelihood of staying in science?
    - What are the principal factors that shape the ECR experience of various cohorts in the sciences in Australia?
    - What are the motivations for ECRs leaving the sciences?
    - What are the specific features of the experiences and environment of those ECRs who remain in the sciences?

6) Publications: Provide details of research dissemination outcomes for the previous year resulting from this project: eg: Community seminars; Conference attendance; Government reports and/or research publications

Publications:

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. R. (2020a). Survey of Australian STEMM Early Career Researchers: Job insecurity and questionable research practices are major structural concerns. BioRxiv, 2020.02.19.955328. https://doi.org/10.1101/2020.02.19.955328. Published as a pre-print in February 2020; currently under review for eLife.

Christian, K., Johnstone, C., Larkins, J., Wright, W., & Doran, M. (2020b, July 29). What are questionable research practices as reported by ECRs in STEMM in Australia? Research Ethics Monthly. https://ahrecs.com/uncategorized/what-are-questionable-research-practices-as-reported-by-ecrs-in-stemm-in-australia/

Annual/Final Project Report

Human Research Ethics Committee

Presentations:

Christian K *"Challenges faced by early career researchers in the sciences in Australia: Findings and Recommendations* University of Adelaide Faculty of Medicine Early Mid Career Network Meeting Adelaide October 2020

Christian K *What are the motivations for early-career researchers leaving academic research in the sciences in Australia?* University of NSW Postgraduate Student Conference September 2020

7) The HREC welcomes any feedback on:

- **Difficulties experienced with carrying out the research project; or**
- **Appropriate suggestions which might lead to improvements in ethical clearance and monitoring of research.**

8) Signatures

Principal Researcher:	…… …….. Print name: CAROLYN JOHNSTONE	**Date:**	19 Nov 20
Other/Student Researchers:	…….. Print name: K Christian	**Date:**	26/10/2020
	…….. Print name: JO-ANN LARKINS	**Date:**	19/11/2020
	…… …….. Print name: WENDY WRIGHT	**Date:**	

Annual/Final Project Report

Human Research Ethics Committee

Submit to the Ethics Office, Mt Helen campus, by the due date:
research.ethics@federation.edu.au

Appendix B: Survey Questions for "Challenges faced by early-career researchers in STEMM in Australia"

Eligibility

1. Do you have a PhD or doctoral qualification?
   - Yes
   - No -Terminate these
   - Currently studying towards this level of qualification –[Terminate these]

2. What is the number of years since completion of your highest degree?
   - 0–1
   - 2–4
   - 5–7
   - 8–10
   - More than 10 years – [terminate these]

3. What is the nature of your employment? (New question, no match)
   - University, teaching position
   - University, research only position
   - University, combined teaching and research position
   - University and hospital, combined clinical and research position
   - Government research institute (e.g. CSIRO, ANSTO) [terminate these]
   - Research institute
   - Not for profit organisation – [terminate these]
   - Other, please specify

Demographics

4. What is your gender?
   - Male
   - Female
   - Other
   - Prefer not to say

5. What is your age?
   - Less than 25
   - 25–30
   - 31–35
   - 36–40
   - 41–45
   - Over 45

6. Where were you born? If Other please specify your country. (countries determined by ABS data on HDR student population)
   - Australia
   - England
   - New Zealand
   - India
   - Italy
   - Vietnam
   - Philippines
   - China
   - Nepal
   - Malaysia
   - Brazil
   - Other (please specify)

7. Is English your first language?
   - Yes
   - No

8. Do you speak a language other than English at home? (If more than one language other than English, provide the one that is spoken most often)
   - No, English only
   - Yes, Mandarin
   - Yes, Italian
   - Yes, Arabic
   - Yes, Cantonese
   - Yes, Greek
   - Yes, Vietnamese
   - Yes, other (please specify)

9. Where did you receive your PhD or doctoral qualification? (countries determined by ABS data on HDR student population)
   - Australia
   - England
   - New Zealand

- India
- Italy
- Vietnam
- Philippines
- China
- Nepal
- Malaysia
- Brazil
- Other (please specify)

10. What is your primary research discipline? Select the appropriate Australian FOR code:
    - DIVISION 01 MATHEMATICAL SCIENCES
    - DIVISION 02 PHYSICAL SCIENCES
    - DIVISION 03 CHEMICAL SCIENCES
    - DIVISION 04 EARTH SCIENCES
    - DIVISION 05 ENVIRONMENTAL SCIENCES
    - DIVISION 06 BIOLOGICAL SCIENCES
    - DIVISION 07 AGRICULTURAL AND VETERINARY SCIENCES
    - DIVISION 08 INFORMATION AND COMPUTING SCIENCES
    - DIVISION 09 ENGINEERING
    - DIVISION 10 TECHNOLOGY
    - DIVISION 11 MEDICAL AND HEALTH SCIENCES

About your family situation

11. Do you live with a partner or spouse? (Bell & Yates, 2015) but added 2nd and 3rd "yes" answers
    - Yes –partner of the opposite sex
    - Yes – same sex partner
    - Yes – prefer not to specify
    - No

12. What best describes your partner/spouse's employment status? Bell & Yates, 2015)
    - My partner works full time in science
    - My partner works part time in science
    - My partner works full time in another sector
    - My partner works part time in another sector
    - My partner is retired or not employed
    - Not applicable

13. Do you have any children under 18 living at home with you? (Bell & Yates, 2015) but added "some of the time"
    - Yes
    - No
    - Some of the time

14. Who is mainly responsible for the care of these children? (Bell & Yates, 2015)
    - I am
    - My partner is
    - We share the care equally
    - Not applicable

15. Are you responsible for the care of any adult due to their ill-health, age or disability? (New question, no match)
    - No
    - Yes (please explain)

About your job and work status and workload

16. What is the name of your institution? (optional)

17. On average, how many hours per week do you work in your workplace, including in field or clinical settings? (Bell & Yates, 2015)
    - Up to 20
    - 21-30
    - 31-40
    - 41-50
    - 51-60
    - 61-70
    - Greater than 70

18. On average, how many hours per week do you undertake work related to your employment at home? (Bell & Yates, 2015)
    - Up to 5 hours
    - 6-10 hours
    - 11-15 hours
    - 16-20 hours
    - 21-30 hours
    - Greater than 30 hours
    - Other, please specify

19. What is your employment fraction? (i.e. 0.2 =one day per week) Variation of (Bell & Yates, 2015)
    - 0.2 FTE
    - 0.4 FTE
    - 0.5 FTE
    - 0.6 FTE
    - 0.8 FTE
    - 1.0FTE
    - Other, please explain

20. How would you describe your overall workload? (Coussens, 2017)
(much too low, about right, too high)

21. In an ideal world, compared to your current workload, how much time would you like to spend on the following tasks? (Coussens, 2017) with clinical work added

	I would like to do more of this	I would like to do about the same	I would like to do less of this	Not applicable
Research (active involvement in experiments, data collection, analysis, report writing)	○	○	○	○
Teaching (including preparation and assessment)	○	○	○	○
Training and supervision (of students/postdocs/staff)	○	○	○	○
Clinical work	○	○	○	○
Fundraising/applying for grants	○	○	○	○
Administration (paperwork, committees, departmental meetings, etc.)	○	○	○	○
Service (voluntary services within organization, counselling colleagues/students, etc.)	○	○	○	○

22. Thinking about all of your paid, unpaid, and other research activities since receiving your doctorate/doctorate-equivalent degree, have you: (Select all that apply) (Phou, 2014) with co-supervised added

    - ○ Published papers in conference proceedings?
    - ○ Had articles accepted for publication or already published in a peer-reviewed journal?
    - ○ Submitted articles for publication in a peer-reviewed journal; that were not accepted for publication or published?
    - ○ Published books or book chapters?
    - ○ Been named as an inventor on a patent application(s)?
    - ○ Been awarded peer-reviewed grant funding?
    - ○ Supervised or co-supervised HDR students to completion?

About Your Job Security and your Funding

23. In which manner are you employed: (New question, no match)
    - Full time continuing
    - Part time continuing
    - Full time fixed term contract
    - Part time fixed term contract
    - Contractor / self employed
    - Other (please specify)

24. If you are on a fixed term contract, what is the total length of your [fixed-term] contract? (Bell & Yates, 2015)
    - Less than 1 year
    - 1 to three years
    - More than 3 years (please specify in comment)

A postdoctoral appointment, or "postdoc," is a temporary position awarded in academe, industry, government or a non-profit organization primarily for gaining additional education and training in research. For the next question, please include any position you consider to be a "postdoc" even if your employer did not or does not. Please also count reappointments to the same position as one appointment. (Phou, 2014) plus "please specify in Other"

25. How many postdoctoral appointments have you had, including your current position if applicable? Select one. If "other" please explain.
    - 1
    - 2
    - 3
    - More than 3 (please specify in Other)
    - Other

26. How is the major component of your salary funded? If Other please explain (Bell & Yates, 2015) plus "Other please specify)
    - I have my own grant
    - I am employed on someone else's grant
    - I am a direct employee
    - I am self employed
    - A combination of two or more of the above
    - Other (Please specify)

27. Does the nature of your research mean you require additional funding in addition to your salary funding to do your research? (New question, no match)
    - Yes
    - No

28. Please explain how your research costs are funded. If "Other" please explain. (New question, no match)
    - My salary and research costs are funded together in one grant
    - My salary is funded by one grant/fellowship; my research costs are funded by separate grants
    - I receive funding for my salary only; I do not have separate research costs
    - Other

29. From which of the following did you receive funding in the last three years? (Check all that apply) (Coussens, 2017)
    - Your own institution
    - Government entities in your own country
    - Business or industry (Australian)
    - Private not for profit (Australian)
    - International entities
    - Others (Please specify)

30. Do you currently have adequate funding to allow you to carry out your research? (New question, no match)
    - Yes
    - No

Job satisfaction

31. To what extent do you agree with the follow statements about your current job? (Bell & Yates, 2015)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am confident my work/contributions are valued by my employer	○	○	○	○	○
I'm confident I can get research grants	○	○	○	○	○
I'm confident I can publish in good journals	○	○	○	○	○
Overall, I find my work rewarding	○	○	○	○	○
I have good career or promotion opportunities	○	○	○	○	○
I have an unreasonable amount of administrative work	○	○	○	○	○
I have good job security	○	○	○	○	○
I have freedom to pursue my own research interests	○	○	○	○	○
I have adequate equipment and resources to do my job	○	○	○	○	○
I am satisfied with my level of income	○	○	○	○	○
I am able to influence decisions that affect me	○	○	○	○	○
I feel safe in my work environment/workplace	○	○	○	○	○
I am satisfied with my workplace's commitment to a diverse and inclusive workplace	○	○	○	○	○

32. Thinking about your current workplace to what extent you are satisfied with the following? (Bell & Yates, 2015)

	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied	Very dissatisfied
The criteria for promotion	○	○	○	○	○
The culture of my workplace	○	○	○	○	○
The leadership and management of my workplace	○	○	○	○	○
Opportunities for attending conferences and study leave	○	○	○	○	○
Support for career development/professional development	○	○	○	○	○
Level of resources and equipment to do my job	○	○	○	○	○
Flexibility of working hours	○	○	○	○	○

33. If there was one factor you could change that would make a major difference to your levels of job satisfaction what would it be? (Select one ONLY) (Bell & Yates, 2015)

- Improved working hours
- More protected time for research
- Improved leave provisions
- Improved institutional / organisational culture
- Improved promotional opportunities
- Better pay
- Improved job security
- Improved mentorship / supervision
- More family friendly environment
- Support for career development
- Other (please specify)
- None of these. I am very satisfied with my current job

34. Thinking about the last job you left, what was the reason for leaving? (tick all that apply) (New question, no match)
    - Lack of funding for new contract/further employment
    - Career progression / development
    - The new job is better suited to my interests / skills
    - For better compensation / salary
    - For full-time permanent position
    - Better work-life balance
    - Unhappy with role
    - Looking to relocate / partner was relocated
    - Launch my own business
    - Terminated / made redundant
    - Maternity / paternity leave
    - Retired
    - Personal reasons
    - Unhappy with organisational culture
    - I was subjected to bullying or harassment at work
    - I'd prefer not to say
    - Not applicable
    - Other, please specify

35. To what extent do you agree that your institution both recognises and values the contributions that you make to...(Vitae, 2018)

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Don't know	Not applicable
Grant / funding applications?	○	○	○	○	○	○	○
Knowledge transfer / commercialisation activities?	○	○	○	○	○	○	○
Managing budgets / resources?	○	○	○	○	○	○	○
Peer reviewing?	○	○	○	○	○	○	○
Publications?	○	○	○	○	○	○	○
Public engagement with research?	○	○	○	○	○	○	○
Supervising / managing research?	○	○	○	○	○	○	○
Supervising research students?	○	○	○	○	○	○	○
Teaching and lecturing?	○	○	○	○	○	○	○

About challenges relating to your work

36. To what extent have the following characteristics of your workplace culture impacted you or your career advancement? new question, but variation of (Coussens, 2017)

VERY SUPPORTIVE- SUPPORTIVE - NEITHER SUPPORTIVE NOR A PROBLEM – NOT SUPPORTIVE/A PROBLEM – VERY UNSUPPORTIVE/ A MAJOR PROBLEM - NOT APPLICABLE

- Level of support from supervisor/manager in applying for promotion
- Guidance received in performance reviews
- Opportunities for professional development
- Opportunities to undertake/complete qualifications
- Access to research funding
- The attitude towards people of my age
- The attitude towards people of my gender
- The attitude towards people of my ethnic background
- The attitude towards people of my sexual orientation
- Availability of informal mentoring

37. To what extent have the following negative characteristics of some workplace cultures impacted you or your career advancement in your workplace? (New question, no match)

NEVER A PROBLEM - SOMETIMES A PROBLEM - A SIGNIFICANT PROBLEM

- Inequitable hiring practices
- Harassment based on different power position
- Lack of support from institutional superiors
- Questionable research practices of colleagues within my institution
- Questionable research practices of colleagues outside my institution

38. How many times in your career have you had to change location in order to advance your career? (Bell & Yates, 2015)
    - I have never changed location
    - I have moved once
    - I have moved twice
    - I have moved more than twice

39. What has been the most significant impact of the move/s? (Bell & Yates, 2015)

40. Have any of the moves involved international relocation? (Bell & Yates, 2015)
    - Yes
    - No

41. Please indicate how much you agree or disagree with the following statements about balancing your current professional and personal responsibilities. (Phou, 2014)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
You can manage the demands of your position and home life.	○	○	○	○	○
Your work schedule allows you to maintain the overall quality of life you want.	○	○	○	○	○
Your work schedule provides the flexibility to take care of demands at home.	○	○	○	○	○
Your supervisor understands when demands at home interfere with your professional responsibilities.	○	○	○	○	○
Demands at home have slowed down progress on your professional activities.	○	○	○	○	○

About Mentoring and Supervision

42. A mentor is someone who is there to assist you achieve your personal, academic and career exploration goals. This person is not necessarily your supervisor. Do you have a mentor? (New question, no match)
    - o Yes
    - o No

43. In the last five years have you been mentored in a mentoring scheme in your workplace or through a professional society? (Select as many as apply. If other, please specify). (Bell & Yates, 2015)
    - o Yes through a professional society
    - o Yes through my institution's formal scheme with a mentor in my current workplace
    - o Yes, through my institution's formal scheme with a mentor in another workplace
    - o Yes but in an informal arrangement with a mentor in my current workplace
    - o Yes but in an informal arrangement in another workplace
    - o No
    - o Other (Please specify)

44. How beneficial was the mentoring? (Bell & Yates, 2015)
    - o Highly beneficial
    - o Beneficial
    - o Neutral
    - o Not beneficial

45. How important to you for career progression are or have been the following types of support from more senior colleagues or mentors? (Coussens, 2017)

	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
Advice on career decisions	○	○	○	○	○
Introduction to important networks	○	○	○	○	○
Attain a position / job via direct intervention through personal resources (of the supporter)	○	○	○	○	○
Skill training: methodology	○	○	○	○	○
Skill training: fundraising	○	○	○	○	○
Skill training: (scientific) writing	○	○	○	○	○
Skill training: other	○	○	○	○	○

46. Over the past two years (or since taking up your current position if that is more recent) have you participated in a formal staff appraisal/performance review? If "Other", please explain. (Vitae, 2018)
    - o Yes
    - o No
    - o Other (please explain)

47. If you have not had a review what is the reason? If "Other", please specify. (Vitae, 2018)
    - o You're on probation?
    - o You've only recently been appointed?
    - o You haven't been invited to do so?
    - o You haven't arranged this?
    - o You are not eligible?
    - o Other (please specify)

48. [If you participated in your institution's staff review/appraisal scheme in the last two years] How would you rate this scheme's usefulness? (Vitae, 2018)

	Not at all useful	Not very useful	Neither useful or not	Useful	Extremely useful	Not applicable
Overall?	○	○	○	○	○	○
For you to highlight issues?	○	○	○	○	○	○
In helping you focus on your career aspirations and how these are met by your current role?	○	○	○	○	○	○
In identifying your strengths and achievements?	○	○	○	○	○	○
In leading to training or other continuing professional development opportunities?	○	○	○	○	○	○
In leading to changes in work practices?	○	○	○	○	○	○
In reviewing your personal progress?	○	○	○	○	○	○

49. When you started with your current employer how useful did you find the following? (Vitae, 2018)

	Not at all useful	Not very useful	Neither useful or not	Useful	Extremely useful	Offered but not taken	Not offered
Institutional-wide induction programs	○	○	○	○	○	○	○
Departmental /Faculty/Unit induction program	○	○	○	○	○	○	○
The local induction to your current role	○	○	○	○	○	○	○

50. Do you consider yourself a mentor (Coussens, 2017)
    - o Yes

- No

51. If yes, do you have the skills you need to be an effective mentor? (Coussens, 2017)
    - Yes
    - No

About professional development and training

52. To what extent do you agree that…(Vitae, 2018)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
You are encouraged to engage in personal and career development?	○	○	○	○	○
You take ownership of your career development?	○	○	○	○	○
You have a clear career development plan?	○	○	○	○	○
You maintain a formal record of your continuing professional development activities?	○	○	○	○	○

53. In which areas have you undertaken, or would you like to undertake, training in these research and academic skills? (Vitae, 2018) – but broken into two parts. This and next Q)

	Undertaken	Not undertaken, I would like to but have no time	Not undertaken, I would like to but not available	This is of no interest to me currently
Ethical research conduct	○	○	○	○
Grant writing	○	○	○	○
Interdisciplinary research	○	○	○	○
Intellectual property	○	○	○	○
Knowledge exchange	○	○	○	○
Tips for your publishing	○	○	○	○
Research impact	○	○	○	○
Research skills and techniques	○	○	○	○
Teaching or lecturing	○	○	○	○

54. In which areas have you undertaken, or would you like to undertake, training in these generic management skills? (Vitae, 2018)

Budget management	○	○	○	○
Career management	○	○	○	○
Collaboration and teamworking	○	○	○	○
Communication and dissemination	○	○	○	○
Equality and diversity	○	○	○	○
Personal effectiveness	○	○	○	○
Project management	○	○	○	○
Mentoring and being mentored	○	○	○	○
Public engagement	○	○	○	○
Supervision of doctoral/masters students	○	○	○	○

About Career Planning

55. In general, upon the completion of your highest degree, do you agree you were confident in your career prospects (i.e. obtaining a good job, securing funding, etc.). (5 point Likert scale, strongly disagree to strongly agree) (Coussens, 2017)

56. Whom do you primarily rely on for career development advice? If "Other", please specify. (Select one) (Phou, 2014)
    - o Your current supervisor
    - o A previous supervisor
    - o A senior colleague in the department or lab from your current position
    - o A senior colleague from a previous position
    - o Your doctorate/doctorate-equivalent degree advisor
    - o No one
    - o Other (Please specify)

57. How do you learn about career opportunities that are beyond academia? Select all that apply. (Nature Research & Penny, 2017)
    - o Academic career opportunities are the only ones I am interested in
    - o Academia is the only possibility I am aware of
    - o My institution provides relevant workshops and resources
    - o I cold-contact individuals in jobs that sound interesting
    - o My family
    - o A professional society that I am a member of provides this information
    - o Science publications/jobs boards
    - o Journal related to my area of speciality
    - o Online resources including blogs
    - o LinkedIn, Twitter and other social networks
    - o Speaking with people in my lab
    - o Speaking with people in my department
    - o Scientific conferences
    - o Other (please specify)

58. Does your institute have career advisory services for science ECRs? (Nature Research & Penny, 2017)
    - o Yes, but I haven't had any contact with them
    - o Yes, and their offerings have been useful
    - o Yes, but their offerings have not been useful
    - o No
    - o I don't know

59. Which, if any, of the following activities have you done to advance your career? Please select all that apply. (Nature Research & Penny, 2017)
    - o Attended career seminars and/or workshops
    - o Attended networking events
    - o Developed my social media profile
    - o I have worked out an individualized development plan
    - o Discussed my career future with a graduate adviser
    - o Discussed my career future with a mentor
    - o Discussed my career future with a careers counsellor at my institution
    - o Other (please specify)

About whether you are considering a change in your work

60. What are your hopes for your research career? Note: Ignore practical constraints! This question addresses what you'd like to do in an ideal world (Hardy et al., 2016)
    - I'd prefer another job immediately
    - After finishing my current position, I'd look to move away from research
    - I'd like to stay in research for the medium term
    - I'd like to make research my lifetime career
    - Other, (please specify)

61. Within the last five years have you considered any major career or position changes? (Bell & Yates, 2015) plus "Yes, to move to another area within or outside science Q)
    - No I have not considered any major changes in my job
    - Yes, to take another position in the same field of science within Australia
    - Yes, to take another position in the same field of science overseas
    - Yes, to move to a different position within my field such as management / academia/industry
    - Yes, to move to another area within or outside science. Please specify in comment
    - Yes, to retire

62. Did you take any concrete action to make such changes? If "Other", please specify in the comments box. If you wish to provide further explanation please use the comment box. (Bell & Yates, 2015)
    - No
    - Yes, I applied for another position in the same field in Australia
    - Yes, I applied for another position in the same field overseas
    - Yes, I applied for a different position within my field (e.g. to move to management)
    - Yes, I applied for a position outside my field or outside science. Please specify
    - Yes, I plan to retire within the next five years
    - Other (please specify)

63. Where would you like to be in five years' time? (New question – no match)
    - In my role and current position
    - In a higher level role, same workplace
    - In a higher level role, different workplace
    - Similar role different workplace
    - Similar role and field overseas
    - In a management role
    - Not working in science; working elsewhere
    - Working in science outside academia
    - Retired, not working
    - Don't know

64. Where do you expect to be in five years' time? (New question – no match)
    - In my role and current position
    - In a higher level role, same workplace
    - Similar role different workplace
    - Similar role and field overseas
    - In a management role
    - Not working in science; working elsewhere

- Working in science outside academia
- Retired, not working
- Don't know

65. In which area do you expect to work in the long term (say, 10 years +)? (New question – no match)

Career in higher education – primarily research and teaching
Career in higher education – primarily research
Career in higher education – primarily teaching
Career in higher education – primarily research and clinical
Other role in higher education
Research career outside higher education
Self-employment/running your own business
Teaching career outside HE
Self-employed
Other occupations
Don't know

66. In which area do you aspire to work in the long term (say, 10 years +)?? (New question – no match)

Career in higher education – primarily research and teaching
Career in higher education – primarily research
Career in higher education – primarily teaching
Career in higher education – primarily research and clinical
Other role in higher education
Research career outside higher education
Self-employment/running your own business
Teaching career outside HE
Self-employed
Other occupations
Don't know

67. What would be the main reason you would consider leaving a career in research? If "Other" please specify (New question – no match)
    - Family/carer responsibilities
    - Interpersonal problems with your supervisor
    - Inadequate job security
    - A lack of independent positions available
    - A lack of funding
    - Other (please specify)

About Career Breaks

68. Have you have ever taken a period of 6 months or longer away from work anytime during your career? (Bell & Yates, 2015)
    - Yes
    - No
    - Other (please specify)

69. How long was the break that you took? (Bell & Yates, 2015)
    - Up to one year
    - 1 – 2 years
    - 2 – 5 years
    - Greater than 5 years
    - Up to one year, more than once
    - 1 – 2 years, more than once
    - 2 – 5 years, more than once
    - Greater than 5 years, more than once

70. Why did you take time off? (Tick all that apply. If for some other reason, please specify). (New question – no match)
    - For health reasons
    - To start a family or have more children
    - To care for a sick family member
    - To write papers from your dissertation for publication
    - To travel
    - For additional education
    - You could not find employment
    - For some other reason (Please specify)

71. Which best describes your return to work after the break? (Bell & Yates, 2015)
    - I returned to the same position, full time
    - I returned to the same position and became part time
    - I returned to the same employer but to a different position – full time
    - I returned to the same employer but to a different position – part time
    - I did not return to my position, I returned later to a different employer – full time
    - I did not return to my position, I returned later to a different employer – part time
    - Other (please specify)

72. Do you have a long term health condition or disability that restricts you in your everyday activities and has lasted, or is likely to last, for more than 6 months? (New question – no match)
    - Yes
    - No

About the Expectations you had for your Job Satisfaction (new question – no match)

73. How does your job as an early-career researcher meet your original expectations? If you wish to offer an explanation, please do so in the comment section.
    - my job is much better than I expected
    - my job is better than I expected
    - my job meets my expectations
    - my job has more difficulties than I expected
    - my job has many more difficulties than I expected

74. How do these statements following correspond with your views about the nature of your job? (Coates & Goedegebuure, 2007)

rating from strongly agree to strongly disagree:

a) This is a poor time for any young person to begin an academic career in my field.
b) If I had it to do over again, I would not become an academic
c) My job is a source of considerable personal strain

75. How would you rate your overall satisfaction with your current job? (Coates & Goedegebuure, 2007)

5 point scale very satisfied to very dissatisfied

76. It is recognised that there are some difficulties for ECRs in working in a research environment in STEMM disciplines. Why do you choose to stay in academia? **(new question – no match)**

    Open ended, character limitation

Further Comments

77. Is there anything you would like to add which has not been covered in this survey? (New question – no match)

Open ended, character limitation

Questions about further contact (parallel survey)

1. After analysing the data from the survey, we may be conducting interviews to further explore the topics relevant to early career scientists such as yourself. Interviews will be conducted in person or via Skype and will take about one hour. Would you like to be considered for such an interview?
    - Yes
    - No

2. Would you be willing to be contacted by our team for any follow-up research in the future?

3. Would you like to receive a copy of the final study report? If so, please leave your email address
    - Yes
    - No

Please enter your email address so we can contact you if yes to any of the previous questions

Parallel Survey

Opening Comment

This parallel survey invites you to leave contact details if you are interested in taking part in follow up research or receiving results.

End Comment

Thank you for taking part in this survey. We may be in touch with you for a follow up interview if we find it necessary and if you have provided your details.

We will keep your details for follow up research, if you have agreed that we may do so.

We will send you research results at the end of the project, if you have asked to receive them.

References

Bell, S., & Yates, L. (2015). Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne.

Coates, H., & Goedegebuure, L. (2007). The Australian Academic Profession in 2007 Survey Methodology and Response Analysis. Australian Council for Educational Research.

Coussens. (2017). Coussens GloSYS Africa Appendix 1_Survey and Consent v2.0 (Global Young Academy, Ed.).

Hardy, M. C., Carter, A., & Bowden, N. (2016). What do postdocs need to succeed? A survey of current standing and future directions for Australian researchers. Palgrave Communications, 2, 16093. https://doi.org/10.1057/palcomms.2016.93

Nature Research, & Penny, D. (2017). Nature Graduate Survey 2017. https://doi.org/10.6084/m9.figshare.5480716.v3

Phou, K. (2014). Questionnaire for National Science Foundation Survey 2015. https://www.nsf.gov/statistics/srvyecd/#sd&qs&tabs-1

Vitae. (2018). Background for Careers in Research Online Survey. https://www.vitae.ac.uk/impact-and-evaluation/cros

Appendix C: Interview Questions for ECRs who have Recently Left Research

Demographic Questions

- How many years post doc?
- Age
- Discipline
- Current workplace or work type
- Time since left university or research institute

What were the main reasons you moved away from academic research?

What do you miss about academic research?

What is good about your new work situation?

What is different about your new work situation?

Where do you hope to be in 5 years' time?

Where do you expect to be in 5 years' time?

During your time in academia, were you aware of people subjected to bullying and harassment?

Were you subjected to bullying and harassment?

- By superiors or peers?

During your time in academia, were you aware of people committing data fraud?

During your time in academia, were you offered career planning either for life within academia or outside?

- Did you take it up?

Were you offered professional development?

- Did you take it up?

What do you think it takes to be the person who makes it?

Appendix D: Themes Table

Theme	Sub-Theme	Sub-sub theme (keyword)
Alternate Careers	• Benefits of new environment	
	• Clinician researcher	
	• Disadvantages of alternate career	
	• Non-research career paths	• Consulting • Government • Industry or private enterprise • Left science • Other • Science communication • Staff Scientist • University research manager
	• What do you miss?	
Career Planning	• Career progression	
	• Lack of career planning	
	• Planning for alternate careers	
Challenges	• Chronic health condition	
	• Difficulties when mature ECR	
	• Family responsibilities	• Consequences when a science partner • Parental caring • Other (non-child) caring responsibilities
	• Funding challenges	• Funding for oneself • Sourcing funding for others in team • Have to work as Research Assistant

	• Inappropriate behaviours	• Bias and discrimination
		  o Age bias
		  o Gender bias
		  o Racial bias
		• Bullying and harassment
		  o Sexual harassment
		• Difficult people
		• Gender inequity
		• Inequitable hiring
		• Questionable research practices

	• Issues for men	

	• Issues for women	• Child bearing and responsibility • Hard to speak up • Lack of mentoring from women • Lose support network • Special assistance for women
	• Job insecurity • Lack of diversity	

	• Need to relocate	• Benefit of relocation
		• Disadvantages of relocation
		  ○ Impact on spouse
		  ○ Lose momentum

	• Residency compliance • Stress and over-competitive environment	
	• Work-life balance	• Workload (too much work) • Too much administration • Need for part time work • Need more time for research • Teaching load • Work can't be stopped/can't get off treadmill • Work can't be stopped – lab needs me
Expectations of ECRs	• Expectations at the start • Expectations for the future	
Institutional infrastructure	• Good support offered • Hard for RAs (research assistants) • Lack of institutional support • Should there be Research Scientist positions • Too many PhD students	

Intention to leave	• Consider moving overseas • Falling out of love with research • Intention to go back • Stay because have a job • Too late to change • Waste of study to leave • Where do they go • Where else to go – no skills for elsewhere	
Job satisfaction	• Factors contributing to satisfaction • Factors contributing to job dissatisfaction	• Continuing to learn • Diverse • Enjoy colleagues • Enjoy teaching or training • Flexibility • Feel valued • Independence • Salary • Dissatisfied with salary • Feel trapped • Feel isolated • Feel under-valued
Leadership	• Leadership training • Poor leadership • Qualities of good leadership	
Mentoring	• Bad mentoring • Good mentoring • Lack of mentoring	
Professional development	• Pertinence of the book • Skills and Training	
Recommendations for change		
Success as a researcher	• Characteristics of who doesn't make it • Characteristics of who makes it	

	• Need to make a difference • Measuring success • Need for publications • Serendipity
Supervision	• Bad supervision • Good supervision • Lack of supervision • Want more independence
	•
Vocation – researchers love research	• Cannon fodder • Work for free
Workplace culture	• Good workplace culture • Unsatisfactory workplace culture

Appendix E: Relevance and Clarity Assessment Tool for Survey Questions

Assessment of new questions for "Challenges faced by early-career researchers in the sciences in Australia and the consequent effect of those challenges on their careers: a mixed methods project" survey

A survey has been created to collect quantitative data from respondents in an on-line survey of ECRs working in a scientific environment in universities and research institutes across Australia.

The questionnaire for the survey has been developed by first compiling questions, often used in a broader or international context, from research literature including questions from Australian Council of Education Research, The EMCR Forum (part of Australian Academy of Science), Federation of Australian Scientific and Technological Societies (FASTS) (Bell & Yates, 2015), Global Young Academy (Coussens, 2017), National Science Foundation (Phou, 2014), Nature (Nature Research & Penny, 2017) and Vitae (Vitae, 2018) in order to cover all the themes identified in the literature as matters relating to job satisfaction or dissatisfaction. Some additional questions were created if no suitable question was identified elsewhere. Questions were combined and modified to create a question bank for this survey relevant to the research questions and the Australian context.

Matters investigated include inequity, bias or discrimination with respect to age, gender, sexuality or race, inequitable hiring practices and harassment based on different power positions, mentoring and supervision, career planning, training and professional development and work life balance. The data from these questions were supplemented by questions seeking demographic information which included the institution type, research discipline, country of origin, family situation and work arrangements.

The questions below which require assessment for relevance and clarity are the new questions included in the survey. They are numbered as they appear in the survey. Q76 is the last question.

Relevance and Clarity Assessment Tool

"Challenges faced by early-career researchers in the sciences in Australia and the consequent effect of those challenges on their careers: a mixed methods project."

Please assess each question for:

- Relevance – is this question relevant to a study examining factors contributing to job satisfaction and intention to leave for early career researchers in the sciences? (1= not relevant; 2=somewhat relevant; 3= quite relevant; 4= highly relevant)
- Clarity – is this question clear? Is there any uncertainty or ambiguity. (1= not clear; 4= totally clear)

Question	Relevance	Clarity
Eligibility		
3. What is the nature of your employment? o University, teaching position o University, research only position o University, combined teaching and research position o University and hospital, combined clinical and research position o Government research institute (e.g. CSIRO, ANSTO) [terminate these] o Research institute o Not for profit organisation – [terminate these] o Other, please specify	1 2 3 4	1 2 3 4
Demographics		
6. Where were you born? If Other please specify your country (countries determined by ABS data on HDR student population) o Australia o England o New Zealand o India o Italy o Vietnam o Philippines o China o Nepal o Malaysia o Brazil o Other (please specify)	1 2 3 4	1 2 3 4
10. What is your primary research discipline? Select the appropriate Australian FOR code: o DIVISION 01 MATHEMATICAL SCIENCES o DIVISION 02 PHYSICAL SCIENCES o DIVISION 03 CHEMICAL SCIENCES o DIVISION 04 EARTH SCIENCES o DIVISION 05 ENVIRONMENTAL SCIENCES o DIVISION 06 BIOLOGICAL SCIENCES	1 2 3 4	1 2 3 4

o DIVISION 07 AGRICULTURAL AND VETERINARY SCIENCES o DIVISION 08 INFORMATION AND COMPUTING SCIENCES o DIVISION 09 ENGINEERING o DIVISION 10 TECHNOLOGY o DIVISION 11 MEDICAL AND HEALTH SCIENCES		
About your family situation		
11. Do you live with a partner or spouse? Bell but added extra two yes answers o Yes –partner of the opposite sex o Yes – same sex partner o Yes – prefer not to specify o No	1 2 3 4	1 2 3 4
15. Are you responsible for the care of any adult due to their ill-health, age or disability? o No o Yes (please explain)	1 2 3 4	1 2 3 4
About Your Job Security and your Funding		
23. In which manner are you employed: o Full time continuing o Part time continuing o Full time fixed term contract o Part time fixed term contract o Contractor / self employed o Other (please specify)	1 2 3 4	1 2 3 4
Job satisfaction		
34. Thinking about the last job you left, what was the reason for leaving? (tick all that apply) o Lack of funding for new contract/further employment o Career progression / development o The new job is better suited to my interests / skills o For better compensation / salary o For full-time permanent position o Better work-life balance o Unhappy with role o Looking to relocate / partner was relocated o Launch my own business o Terminated / made redundant o Maternity / paternity leave o Retired o Personal reasons o Unhappy with organisational culture	1 2 3 4	1 2 3 4
About challenges relating to your work		
36. To what extent have the following characteristics of your workplace culture impacted you or your career advancement? Very Supportive- Supportive - Neither Supportive nor a Problem – Not Supportive /A Problem – Very Unsupportive / A MajorProblem - NOT APPLICABLE	1 2 3 4	1 2 3 4

o Level of support from supervisor/manager in applying for promotion o Guidance received in performance reviews o Opportunities for professional development o Opportunities to undertake/complete qualifications o Access to research funding o The attitude towards people of my age o The attitude towards people of my gender o The attitude towards people of my ethnic background o The attitude towards people of my sexual orientation o Availability of informal mentoring		
About Mentoring and Supervision		
42. A mentor is someone who is there to assist you achieve your personal, academic and career exploration goals. This person is not necessarily your supervisor. Do you have a mentor? o Yes o No	1 2 3 4	1 2 3 4
About whether you are considering a change in your work		
62. Where would you like to be in five years' time? o In my role and current position o In a higher level role, same workplace o In a higher level role, different workplace o Similar role different workplace o Similar role and field overseas o In a management role o Not working in science; working elsewhere o Working in science outside academia o Retired, not working o Don't know	1 2 3 4	1 2 3 4
63. Where do you expect to be in five years' time? o In my role and current position o In a higher level role, same workplace o Similar role different workplace o Similar role and field overseas o In a management role o Not working in science; working elsewhere o Working in science outside academia o Retired, not working o Don't know	1 2 3 4	1 2 3 4
64. In which area do you expect to work in the long term (say, 10 years +)? o Career in higher education – primarily research and teaching o Career in higher education – primarily research o Career in higher education – primarily teaching o Career in higher education – primarily research and clinical o Other role in higher education o Research career outside higher education	1 2 3 4	1 2 3 4

o Self-employment/running your own business o Teaching career outside HE o Self-employed o Other occupations o Don't know		
65. In which area do you aspire to work in the long term (say, 10 years +)? o Career in higher education – primarily research and teaching o Career in higher education – primarily research o Career in higher education – primarily teaching o Career in higher education – primarily research and clinical o Other role in higher education o Research career outside higher education o Self-employment/running your own business o Teaching career outside HE o Self-employed o Other occupations o Don't know	1 2 3 4	1 2 3 4
66. What would be the main reason you would consider leaving a career in research? If "Other" please specify o Family/carer responsibilities o Interpersonal problems with your supervisor o Inadequate job security o A lack of independent positions available o A lack of funding o Other (please specify)	1 2 3 4	1 2 3 4
About Career Breaks		
69. Why did you take time off? (Tick all that apply. If for some other reason, please specify). For health reasons o To start a family or have more children o To care for a sick family member o To write papers from your dissertation for publication o To travel o For additional education o You could not find employment o For some other reason (Please specify) o Other (please specify)	1 2 3 4	1 2 3 4
71. Do you have a long term health condition or disability that restricts you in your everyday activities and has lasted, or is likely to last, for more than 6 months? o Yes o No	1 2 3 4	1 2 3 4
About the Expectations you had for your Job Satisfaction		
73. How does your job as an early-career researcher meet your original expectations? If you wish to offer an explanation, please do so in the comment section. o my job is much better than I expected o my job is better than I expected	1 2 3 4	1 2 3 4

○ my job meets my expectations ○ my job has more difficulties than I expected ○ my job has many more difficulties than I expected		
75. How would you rate your overall satisfaction with your current job? 5 point scale very satisfied to very dissatisfied	1 2 3 4	1 2 3 4
76. It is recognised that there are some difficulties for ECRs in working in a research environment in STEMM disciplines. Why do you choose to stay in academia?	1 2 3 4	1 2 3 4

Do you have any additional notes you would like to make on any of the questions?

Position: ----------

Years experience: ----------

References

1. Bell S, Yates L. Women in the Science Research Workforce: Identifying and Sustaining the Diversity Advantage. University of Melbourne; 2015.
2. Coussens. GloSYS Africa Appendix 1_Survey and Consent v2.0. Global Young Academy, editor. 2017.
3. Phou K. Questionnaire for National Science Foundation Survey 2015 [Internet]. 2014. Available from: https://www.nsf.gov/statistics/srvyecd/#sd&qs&tabs-1
4. Nature Research, Penny D. Nature Graduate Survey 2017 [Internet]. 2017 [cited 2020 Jan 7]. Available from: https://figshare.com/articles/Nature_Graduate_Survey_2017/5480716
5. Vitae. Background for Careers in Research Online Survey [Internet]. 2018. Available from: https://www.vitae.ac.uk/impact-and-evaluation/cros

Appendix F: Answers Coded in NVivo to Intention to Leave

Q60 Other what are your hopes for your career?

if workload was lower, then I would love to stay in my job, even without promotion prospects. If that's not possible (what I believe) to reduce working hours, then the best decision is to leave immediately (which is what I am about to do) (Survey respondent 384)

not in research anymore (thankfully) (Survey respondent 616)

Q62 did you take action to make a change? (other responses)

I am looking to go into high school teaching for better work life balance and job security (Survey respondent 88)

I am working on an exit strategy from my organisation over the next 6 months. I am looking at possibilities for future employment. (Survey respondent 128)

I am constantly on the look out [sic] for new opportunities and will apply if they are in a more desirable location for me to live (closer to family) - so far have been unsuccessful... (Survey respondent 132)

I have successfully applied for a role w federal government. (Survey respondent 384)

I applied for a range of academic, research, technical, managerial and information technology positions that had more clear future prospects. The private sector did not seem interested in my academic background. Retraining is an option, but is likely to come at a significant cost to my current academic path. (Survey respondent 479)

I made a decision to give myself 2 years to test if Academia is for me. Given that I have been miserable for the 90% of time and felt good for 10% (primarily due to the culture at the workplace), I am not sure if I want to stick around in academia. The only way to keep me in academia is a permanent contract. (Survey respondent 562)

I am currently looking outside academia to get away from the culture of harassment... it takes too much of a toll on my health... but I would stay in academia if I were to find a position that didn't subject me to harassment by a supervisor. (Survey respondent 589)

I have often contemplated moving completely away from academia, science and become a gardener or something. The stress related to lack of funding primarily, but also publishing demands and general negativity/adversarial competition in academia can sometimes become too much and really effect one's mental health (Survey respondent 630)

I have applied for over 30 positions, academic and non-academic, within Australia in the past 12 months. 5 interviews later still nothing and I'm exhausted (Survey respondent 642)

I'm currently trying to work out what other fields I am qualified to work in and that I would enjoy. I have been doing informational interviews with people who i think might have interesting jobs and to try to work out how to transition to other jobs. I follow alt-ac people on Twitter to help me work out how to make (Survey respondent 657)

Yes, I applied for research projects in Europe (Survey respondent 659)

admin work at university (Survey respondent 666)

I have to apply globally. I go wherever I get a job. (Survey respondent 703)

I've applied all over the place. (Survey respondent 713)

I have changed my mind and am looking forward to jobs outside of academia. (Survey respondent 839)

And I also applied for jobs overseas in academy and out side [sic] Academy (Survey respondent 849)

Tried applying in the industry. (Survey respondent 860)

I've considered leaving due to feeling swamped by an unrealistic work load and a lack of job security. (Survey respondent 870)

Q73 Expectations (Explanations)

After 4 years in the position, I made a hard decision to leave. (Survey respondent 96)

My current 0.2FTE was my decision so I can also study my Bachelor of Midwifery degree. (Survey respondent 234)

Instead, I am focus [sic] on project administration, team management, and constantly applying for funding for my salary and my research. I feel everyday that the expectations are greater, but with less and less funding to achieve the goals we are set. It's very unmotivating, negatively impacts my quality of life, and I am definitely considering a move in the short to medium term if it does not improve. (Survey respondent 515)

And now after seeing the pressure that Australian Universities place on staff, I am not 100% certain that I want to or can stay in this type of role despite loving the type of work I do. (Survey respondent 613)

I thought I could tolerate the uncertainty, long hours and pressure and I can, but I no longer think it's worth it to do so (Survey respondent 880)

Q76 Why do you stay?

As soon as I am in a position a [sic]to leave I will, I am here for a specific reason with a specific plan (Survey respondent 440)

I'm not sure where I will go next, but it will be somewhere with more job security, and more women and family friendly. In that regard, it was probably not necessary for me to have done my PhD. My colleagues and peers who didn't do a PhD have much more lucrative and financially and lifestyle rewarding careers. (Survey respondent 493)

I've been surprisingly successful at it-despite the hardships-and want to see how long I can cling on/persevere through the storm (Survey respondent 192)

I still haven’t found a non-academic job that I’m qualified to do that pays as well as my post doc position. (Survey respondent 646)

it will be the time I will seek career change that is outside of academia. (Survey respondent 533)

Once she gets that job, I will quit academia and move overseas, unless I am offered a permanent job at a workplace with better culture than where I am right now. (Survey respondent 562)

I am considering leaving academia. (Survey respondent 88)

I am planning to leave within the next 6 months. (Survey respondent 128)

I have seen so many great ECRs leave research because of the challenges of finding work, meeting expectation, attracting grants. I think the field is too competitive and does not take care of our ECRs and we are poorer for it. (Survey respondent 372)

I wasn't expecting it to be this tough. I am actively looking for alternative work. (Survey respondent 785)

I don't, am transitioning out of academia (Survey respondent 528)

I love what I am doing but I am aware of the difficulties to pursue this career in a longer term. (Survey respondent 60)

That said, I'm not sure I will stay. Once the survey is complete and published, I may properly look elsewhere, since no one in academia wants me. (Survey respondent 713)

I recognise that it is a rare opportunity, even if it is stressful and difficult. It is what I personally want to do and returning to it later in life appears to be near impossible, so I will continue in the field for now. (Survey respondent 141)

I'm about to give up. (Survey respondent 742)

I've spent 10 years training to be an academic. I want to be an academic, but it seems it just isn't my choice at the end of the day. I'll stay until I am no longer competitive. I am keeping my eyes open and looking at other opportunities but so far no one wants me outside academia either (Survey respondent 194)

I'm not sure I'll be so lucky in 4 months when my contract expires positions still available, once it runs out, I will likely move away from it (Survey respondent 179)

Q77 Is there anything else?

After four years of waiting for a job to come up and volunteering all my spare time to assist in research, including supervising honours and masters students, I am thinking of giving up. (Survey respondent 88)

Workload balance. I accepted my short-term contract 0.8 FTE job with the expectation that I could use the 0.2 left over for my research (without pay), but my teaching workload quickly enveloped this. Without enough time to research and publish, and no job security beyond 1 year, it is hard to see any possibility that I will be able to stay in research at the end of this contract. I believe my experience of teaching commitments pushing out time for research/publication (and therefore possible career advancement) is relatively common. Job security. From talking to my peers from my PhD candidature, now scattered across the world, taking these risks (ie. short-term contracts, part time employment, working enormous hours) is standard. I do not blame my institution for my working conditions, my impression was and is that it is par for this career course in Australia. It is a difficult and time-consuming career path, but that in itself isn't the problem - I would work even more hours (somehow!) if I had job security and time to research (Survey respondent 141)

The personal toll it takes to have an academic position is immense. The job insecurity, being unable to plan for anything beyond 1-maybe 2 years is debilitating. Constantly responding to this opportunity, and that opportunity, doing good clever work and being available at all times is tough beyond measure. Not knowing if all this personal sacrifice and tough hard work are even going to be worth it is downright demoralizing. It might all work out, and it might not - but when do you pull the pin?? (Survey respondent 194)

Biggest problem with academia is a lack of jobs (someone has to die for a position to become available). People tell me to not give up and they are glad they are not in my position (not helpful; makes me more depressed). Was employed as postdoc and my supervisor was MIA for the 3yrs- I think this really hindered my research output and professional development. Currently in a fixed-term contract - again just contributes to being depressed and wanting to leave academia (because there is no job security). I have more teaching experience (admin, unit coordination and teaching big units (>100 students)) than some professors employed at a top university and I still can't get a permanent job in academia Constantly applying for jobs is really bad for my mental health - I have been applying for jobs since 6 months before I handed in my PhD 8 years ago. Apologies for the rant :-) (Survey respondent 200)

Something needs to change with funding for research in Australia. People wonder why younger people move away or move out of science... of the 20 people I studied with and graduated with at university, only 2 of us are still working in science, and I am studying another degree to open up my employment opportunities. (Survey respondent 234)

Limited opportunities in Australia are challenging, I can’t move to another country (family constraints) so my future will likely not be in academia (Survey respondent 469)

I had a bad run. Some bad advice in one postdoc, and bullying in another, and was forced out of research. I couldn't take the hypercompetitive environment. Despite excellent appraisals and feedback, I was never 'good enough'. So now I'm looking for a new job where I can be good enough (Survey respondent 642)

I think there would be likely multiple reasons for me leaving academic/research, not just a lack of funding, which is what I ticked. Personal responsibilities is another reason why i would leave. (Survey respondent 686)

The lack of funding, research jobs and job stability in STEM in Australia will probably lead to me leaving academia altogether or moving overseas. (Survey respondent 688)

The research climate isn't very appealing in Australia because Australia only has one funding agency. There is no other option to obtain funding other than the ARC. The success rate is so low for any funding proposal. It is even more discouraging when one spends months preparing the grant proposal and yet not receiving the funding even with a good grade. My university also cuts available small grants for travel, career support etc. I came to Australia during the time when Super Science fellowships and centre of excellence in my science field were funded. It attracted so many talented oversea graduates to come to Australia, including my partner and myself. That really put Australia in the forefront of being world best in science. Unfortunately, the plan is short sighted as it can't keep all these people after the fellowships ended. Most of them have left and returned oversea. 7 yrs onward, I'm thinking about leaving academia every time my contract is up. (Survey respondent 755)

Around the time I finished, I had one project management job that was awful (because of my manager) and I left academia for two years and worked as a receptionist. That had its own value which is actually still benefiting me, but I really struggled with the idea that I had a PhD but was working as a receptionist. Since I've been back in academia (2.5 years now), I have been much happier and draw much more value from it. I've only been doing research assistant work but I feel valued and I'm given a great deal of autonomy. I would happily work at this

level for years to come except I know eventually I will be too experienced and too expensive. (Survey respondent 890)

Appendix G: Raw Estimates for the Model

Estimates (Group number 1 - Default model)

Scalar Estimates (Group number 1 - Default model)

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Institutional	<---	Institutional_Choices	1.000				
PersonalOther	<---	Personal_Others	1.000				
WorkingConditions	<---	Working_Conditions	1.000				
PersonalMyWork	<---	Personal_MyWork	1.000				
Q075	<---	Institutional_Choices	1.000				
Q075	<---	Personal_MyWork	1.000				
Q075	<---	Personal_Others	1.000				
Q075	<---	Working_Conditions	1.000				

Standardized Regression Weights: (Group number 1 - Default model)

	Estimate

Intercepts: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Institutional	3.166	.032	99.699	***	
PersonalOther	3.036	.026	115.550	***	
WorkingConditions	3.254	.043	75.901	***	
PersonalMyWork	3.002	.034	89.123	***	
Q075	3.472	.049	71.456	***	

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Personal_MyWork	<-->	Working_Conditions	.041	.033	1.227	.220	
Personal_Others	<-->	Working_Conditions	.045	.026	1.770	.077	
Institutional_Choices	<-->	Personal_Others	.238	.022	10.990	***	
Personal_MyWork	<-->	Institutional_Choices	.338	.029	11.847	***	
Institutional_Choices	<-->	Working_Conditions	.064	.031	2.048	.041	
Personal_MyWork	<-->	Personal_Others	.190	.021	8.837	***	

Correlations: (Group number 1 - Default model)

	Estimate

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Institutional_Choices	-.162	.046	-3.528	***	
Personal_Others	-.215	.039	-5.541	***	
Working_Conditions	-.054	.058	-.922	.356	

Personal_MyWork	-.119	.048	-2.447	.014
eIC	.685	.062	11.076	***
ePO	.480	.050	9.587	***
eWC	.771	.080	9.607	***
ePM	.568	.063	8.961	***
eJS	-.133	.082	-1.636	.102

Squared Multiple Correlations: (Group number 1 - Default model)

	Estimate
Q075	1.116
PersonalMyWork	-.264
WorkingConditions	-.075
PersonalOther	-.811
Institutional	-.310

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	20	.000	0		
Saturated model	20	.000	0		
Independence model	5	661.727	15	.000	44.115

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	1.000		1.000		1.000
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.000	.000	.000
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	.000	.000	.000
Saturated model	.000	.000	.000
Independence model	646.727	566.245	734.613

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	.000	.000	.000	.000
Saturated model	.000	.000	.000	.000
Independence model	.744	.727	.636	.825

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Independence model	.220	.206	.235	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	40.000	40.271		
Saturated model	40.000	40.271		
Independence model	671.727	671.795		

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	.045	.045	.045	.045
Saturated model	.045	.045	.045	.045
Independence model	.755	.664	.853	.755

HOELTER

Model	HOELTER .05	HOELTER .01
Default model		
Independence model	34	42

Appendix H: Detail of Open-text answers from the 92 respondents who selected "Other" for Q62 "Did You Take Any Concrete Action to Make Such Changes?"

These comments are presented in full as collected in LimeSurvey. I note some appear to have been cut off mid-way.

Broad Theme	Individual Responses
Not considering a change	Not applicable.
	no, I fulfil this in my private practice
Another academic position in academia, same field	In the last 5 years, I have relocated twice internationally for another position in the same field.
	During my PhD I had three children Took a part time role in public health for a health service after graduation and my most recent change was back into an academic position
	Before I finished my PhD I was offered a post doc and accepted it.
	I moved from running a small business (consulting) which I was in immediately after my PhD, to academia
	I stated I was going to resign due to working conditions - things changed and I was in the process of applying for another internal role, which I was successful in.
	I did this in between jobs, but was unsuccessful in the applications. Therefore I settled for another job in research. I am happy in research, aside from the job insecurity and pay.
	I also applied for positions overseas, but have applied for more in Australia, so chose that option.
Academic position overseas	Yes, I applied for research projects in Europe
Non research in academia / different position within my field	I inquired about the position but was told I would have visa restrictions so was not eligible to apply (position was at same institution that currently sponsors my visa but the job was Professional, not Academic)
	I am working now in research management within academia
	Informal discussion with other group leaders about transition from Post Doc to Lab Manager role
	I applied for technical, support, or teaching-only roles. I am now in the school of education (different field) in a support role. I have some teaching input
	admin work at university

Change or potential change within science	Journalism/science communication
	I have begun studying a degree in midwifery to move out of science
	Switched from dietetics/nutritional biochemistry to public health
	I applied for a position at CSIRO.
	Successfully changed field from pharmacology to health informatics / interactive media
	diagnostic pathology service
	training
	Looked for science jobs outside of Research
	Yes, I plan to leave academia to move to policy in 6 weeks' time
	I moved from clinical practice to academia
	Moved from a clinical health role to academia
	I changed fields in science to get a job.
	Outside of field as my field of expertise did not offer any jobs outside of private industry
	I used to think being an academic was the only job I could do. But I have changed my mind and am looking forward to jobs outside of academia.
	I applied for a range of academic, research, technical, managerial and information technology positions that had more clear future prospects. The private sector did not seem interested in my academic background. Retraining is an option, but is likely to come at a significant cost to my current academic path.
	Successfully changed field from pharmacology to health informatics / interactive media
	I have successfully applied for a role w federal government.
	Applied for government research position and also trialed high school teaching
Completely different field	I'm a musician/artist and work as a freelancer - I work on that small business consistently
	I was also looking for other income source that is not science but provides financial income
	Pipe-dream Plan B - start a fashion label. Surely not as stressful and demanding as an insecure research career!
	Outside science - accounting.
	Started a cert IV in Pilates instructing
	Considered having a business idea / entrepreneurship
	Applied for a position in a hedge fund (finance sector)
	See previous answer. I started investigating what I would need to do to become a Death Duala. I was considering starting up my own business in community palliative care (for humans) and pet funerals. Then I got this job and am happy, but it is a relief to know there are alternatives.

	I thought about going back to being a farmer, because at least there is endless work available and I could stay in the same place to be with friends and family.
	Yes, I got my yoga teacher training certificate but now have a disability and am unable to support myself full time with yoga teaching. Research isn't as hard on my body so I can do that more easily for better money.
	I'm currently trying to work out what other fields I am qualified to work in and that I would enjoy. I have been doing informational interviews with people who i think might have interesting jobs and to try to work out how to transition to other jobs. I follow alt-ac people on Twitter to help me work out how to make t
	I am looking to go into high school teaching for better work life balance and job security
	I thought about high-school teaching. I looked into courses but never applied
	Teaching
	I have often contemplated moving completely away from academia, science and become a gardener or something. The stress related to lack of funding primarily, but also publishing demands and general negativity/adversarial competition in academia can sometimes become too much and really effect one's mental health. Howeve
	No jobs in an area I wanted to work in were available, so I applied for some non-science positions (I was not successful)
Industry	Job prospects in academia are very limited and a stable, continuous career is, realistically, unlikely. Considered shift away from research into Australian industry for try and obtain job security and some form of work-life balance.
	I have had significant conversations with colleagues in industry about getting out of academia, given that no other university near me seems to have a department doing what I do, and we are fairly committed to this location for a long time
	Connected with people who work for the company I think I want to work for next
	A management position in the Industry
	Tried applying in the industry.
Consideration given to change but decided to stay in academic research	I knew at the end of the year that my current funding was ending, so I researched a move into the field of logistics and planning and went so far as to enrol in a postgrad course. However, my funding was renewed at the end of the year and I realized that the course load would be too much on top of full time work so I [sic]
	Considered a full time clinical governance role in the hospital setting, no action taken as decided to continue with current role.

Consideration given to new jobs but unsuccessful /Don’t know what to do	I just received permanent residency, so have to stay for another 2 years for that to remain valid, then I will look elsewhere. I considered enrolling in a masters of teaching to be a high school science teacher but secured a post-doc instead I have applied for over 30 positions, academic and non-academic, within Australia in the past 12 months. 5 interviews later still nothing and I'm exhausted I made a decision to give myself 2 years to test if Academia is for me. Given that I have been miserable for the 90% of time and felt good for 10% (primarily due to the culture at the workplace), I am not sure if I want to stick around in academia. The only way to keep me in academia is a permanent contract. Otherwise I'm unhappy with my job but I have no idea what else I could do or where to begin looking for another job. Spoke with individuals about pros and cons of advertised positions. ageism is against me and no job offers have accrued I am constantly on the look out for new opportunities and will apply if they are in a more desirable location for me to live (closer to family) - so far have been unsuccessful... I haven't been successful in my applications for permanent positions I have applied for many many jobs in academia, government and private business across my specific research field, the research sector, academia more broadly, and the policy sector. I also enrolled in a grad certificate of policy and governance. And here in Australia I applied inside and outside Australia I apply for pretty much anything when it looks like my contract may not be renewedI [sic] have undertaken courses to boost my chances of employment outside academiaI [sic] visited a careers counselor ($400) And I also applied for jobs overseas in academy and out side Academy I have applied for numerous positions within my institution and have never received an interview, even positions I have been underqualified for (technical officer). After my last job I applied for many positions before being offered the one I am presently employed in. I applied for industry research and scientific management positions and most often did not receive an interview. I also interviewed for technician positions and other postdoc potions and just missed out. It is a ver I find myself in a position where I cannot meet the criteria for promotion to ongoing. This has arisen due to a failure to acquire outside funding (despite excellent comments from peer reviewers during the application process), an

	unwillingness of colleagues to collaborate which has stunted my publication output (no m
	This comment applies to the previous question, which did not have a comment box. I subscribe to an ethical jobs mailing list and if a position came up that suited my financial situation and my skills, I would apply for it.
	I have to apply globally. I go wherever I get a job.
	I've applied all over the place.
Not specified or hard to tell	I am working on an exit strategy from my organisation over the next 6 months. I am looking at possibilities for future employment.
	My fellowship ends 31 Dec 2019. It seems unlikely I will be in working science in 2020 due to a lack of funding.
	My institute has made it clear they will not/cannot support me and given success rates for ARC and NHMRC funding I am uncomfortable merely crossing my fingers. Loss of my full time income would be difficult
	At the time of submitting my PhD I did not have a postdoc position, so was considering all options to get paid work in any field
	My current contract is up soon and I just want a job that isn't short term contract. It's likely that I'm not competitive enough to stay in academia in the city I'd like to live in, despite my desire to. I'd like to hopefully stay in science or in an tertiary education but I really don't know what I'll be able to get.
	no idea still what will happen
	Building my cv to allow me to apply for the careeer [sic] change I want
	Three-year fixed-term contracts are very short. In the first 2 years, I focus on my research, however, in my final year, I am thinking about where I am going next. It takes a lot of time and effort to find something else within the research field. I find having an "exit strategy" important. For me, this is looking for
	Being a postdoc is not a career path, there is not job security and the demands of the jobs are too much while others (the boss) take all the credit. I have been successful in getting grants but those are not paying my salary so I still depend on someone to hire me and despite my efforts and medium success, I do not f
	I took up my first postdoc position in Australia because of my partner. I even changed sub-field after my PhD. I was lucky enough to have that opportunity to learn everything from scratch. It has not been an easy route switching the field. Unfortunately, after years of not giving the opportunity to advance the career,
	I have a 2 body problem and it wasn't clear whether I would get the grant I needed to stay in my field; relocation was off the table.

	I considered many options, talked to people and watched job advertisements - purely because I was not sure if I could get a permanent job in academia and needed Plan B, Plan C etc. I constantly think about leaving academia/research (from necessity not choice) but don't know how and am not qualified for any other jobs Unreasonable prospects for a job outside academia with my qualifications/specialisations I've considered leaving due to feeling swamped by an unrealistic work load and a lack of job security. When considering leaving, I prepared a list of minimum project outputs and placed a time frame around those. I planned to try hard to complete those and if unsuccessful, to leave and try something else. This decision I am currently looking outside academia to get away from the culture of harassment... it takes too much of a toll on my health... but I would stay in academia if I were to find a position that didn't subject me to harassment by a supervisor My wife is a foreign national so I'm always thinking of moving back overseas Workshop attendance