Breaking Bad Barriers to Pursuing Research: A concordat to research equity (part 1)

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Funding: See Acknowledgements.

Peer Review: This article has been subject to a double-anonymised peer review process.

Abstract

This research looked to cast light on intersectional issues by considering barriers faced and connecting the difficulties encountered in pursuing a research career with participation in various identities.

Job instability, international (im)mobility, an undiversified workforce, biases faced in research collaborations and in hiring processes are just some of a wide variety of barriers affecting researchers in their day-to-day work life and in establishing and progressing their careers. Some of these barriers, due to their nature, adversely affect particular identities more than others. This can lead to negative outcomes for individuals who are prevented from successfully pursuing their career of choice, reinforcing identity stereotypes and perpetuating a lack of inclusion.

Our research sought to identify real, potential and perceived barriers that exist to leading or taking part in research, recognising their existence and impact in our own multidisciplinary engineering and science academic department's context. Barriers were explored through a survey in the first instance with subsequent focus groups. We considered 4 macro-areas of barriers: Belonging and Community; Time and Timing; Access to Resources; Communication and Information. This research tested the completeness of our understanding and elucidated the impact of the barriers on researchers' careers. Further, we explored individual and community identity, also considering those groups of people displaying identity traits traditionally underrepresented in academia in STEM, and particularly Engineering, deriving greater nuance from lived experience and the importance of fairness, kindness and belonging in the workplace.

Keywords: equity; barriers; action; identity; careers; researchers; STEM

Introduction

It is commonly understood that there is a 'leaky pipeline' within the career paths of STEM researchers. Many face a host of challenges on their journey to pursuing a role in research, and it has been posited that some of these barriers adversely affect particular groups more than others. This leads to negative outcomes, not only for individuals, but the STEM sector at large. (**British Science Association 2021; Clancy & Goastellec 2007; Crenshaw 1989; EngineeringUK 2021; Department for Education 2024; Guyan & Oloyede 2019; House of Commons 2023; Mitra & Dopson 2024; Moore & Piddini 2023; Palid, et al. 2023; Prince & Francis 2023**).

Our project sought to explore the range of real, potential and perceived barriers that exist to leading or taking part in research in our own academic department's context, ultimately aiming to inform an action plan to support researchers and academics across our community in their pursuit of a fruitful research career.

The diverse Research Team comprised of five members with very varied backgrounds: our lead researcher from Philosophy with very current personal experience of career instability; an undergraduate Sociology student interested in fairness and community behaviour; two STEM academics, one early career and one more experienced, both actively championing inclusive practices for their teams and colleagues; and the Head of Research Support, previously an engineer who had to leave an active STEM career behind herself, with current responsibilities extending to grant support, talent development and research culture. All were actively pursuing, or supporting others to pursue, careers in research, and brought their own experiences of various barriers encountered throughout their careers. This project created a space to explore such obstacles and their effects in a structured way, with immediate opportunities to act on the learnings discovered.

Barriers could be grouped into four categories: Belonging and Community; Time and Timing; Access to Resources; Communication and Information. These were explored through a survey and focus groups to elicit rich and meaningful data, examining the nuances around issues and collecting examples of lived experience. The qualitative data complemented the numerical opinion scales, aiding an enhanced understanding of the types, levels and features of the barriers encountered.

Further, we explored individual and community identity, also considering those groups of people displaying identity traits traditionally underrepresented in academia in STEM, and particularly Engineering. This research looked to cast light on intersectional issues by considering

barriers faced and connecting the difficulties encountered in pursuing a research career with participation in various identities.

In this article we present the findings from our research on our greater understanding of the problems derived from the survey undertaken. Additionally, we intend to subsequently publish our analysis of the focus group discussions and details of our positive action plan with considered solutions to improve the culture, working environment and career opportunities for our research community. Ultimately the aim is to engage to inform practices more widely across the University sector; to create a positive environment for all. As Holly Branson, Chief Purpose and Vision Officer of Virgin Group states:

> *The joy and success of a work culture where everyone feels that they belong, have a shared purpose, and are respected and valued equally to their colleagues, regardless of their gender, ethnicity, neurodiversity, disabilities, or socioeconomic background, should never be underestimated.* (**Branson, 2023: ix-x**)

Background

The current literature on the spectrum of barriers to equality and inclusiveness that are faced within research careers is limited, with a focus on certain protected characteristics. Although there is an interest in developing resources and collecting data relating to Equity, Diversity, and Inclusion (EDI), there is still a warranted need for a more comprehensive approach which goes beyond factors of identity, tackling the various barriers faced by underrepresented individuals and groups across academia. This would support identification of the problems that researchers meet regardless of their identities, enabling supporting services to develop more effective and accurate actions to both enhance diversity and inclusiveness in research and support the research community overall.

Regarding identity, evidence from previous research suggests that those from underrepresented groups are less likely to obtain funding for research, as well as to attain senior positions in academia (**Prince & Francis, 2023**). However, there is little discussion utilising an intersectional scope, for example considering issues caused by (or more often encountered by) individuals with multiple overlapping identities. Intersectionality was initially introduced as an analytical framework for understanding how interrelated and mutually shaping categories of race and gender served to compound inequalities for minoritised people (**Kozlowski, 2022**). Since then, the international framework has been expanded to frame the marginalisation experienced by minoritised groups and the intersection of race, gender, sexual orientation class and other

identities (Ibid). In STEM (and society at large) individuals can experience discrimination as a result of their race, gender, sexual orientation or socioeconomic background, among others. This is invariably compounded for individuals who identify with more than one of the minoritised groups.

A primary focus of current scholarship within the field of EDI is on the ways in which identities are distributed amongst the STEM workforce. The risk with such an approach is that one can often overlook the specific barriers these groups face on a practical, daily basis. The British Science Association's final report on Equity in the STEM Workforce (**2021**) highlights how understanding these barriers can facilitate sustainable improvements and growth within the field. It emphasised that empirical evidence supporting the benefits of diversity and inclusion is currently insufficient, and lacking intersectional data. This points to a gap in the literature and the need for further research, including into the themes which emerged from our literature review of isolation/belonging, time and timing, support, communication, information and resources. Furthermore, the literature shows that there has been arguably a greater focus on gender inequality in STEM careers than other forms: 'While the UK has come a long way towards improving social and economic opportunities for women, inequalities remain in a number of areas' (**Guyan & Oloyede, 2019: 20**). Of relevance to our project, it is suggested that societal inequality might even originate in workplaces, making them critical and also ideal locations to investigate 'continuously complex forms of inequality', (**Acker, 2006: 441**).

In order to obtain a comprehensive understanding of the barriers within the field of STEM in our study, we were interested to investigate intersectional perspectives if possible, considering if there was any evidence that spoke to different, more complex or specific collections of barriers for individuals with multiple overlapping identities. The House of Commons Science and Technology Committee's report (**2023**) stresses that problems of underrepresentation should not be viewed in isolation, as different characteristics can combine to create unique barriers. To explain further, we can trace back to Crenshaw's basement thought experiment, which provides a useful analogy for understanding the intersectional burden of certain individuals. The theory posits that people benefit due to the singularity of their burden, and that the escape hatch located at the top of the basement is available only to those who are multiply burdened if they are willing to pull themselves into single-burdened groups to squeeze through (**Crenshaw, 1989: 151-152**). The British Science Association found such intersectional investigation would take too much resource and time in their 2021 report: 'Analysis of the sector by individual characteristic lacks intersectionality but was the most efficient method of examining the available evidence' (**British Science**

Association, 2021: 19), and encourages readers to consider all of the single-identity evidence in totality, acknowledging that intersectional barriers such as those related to gender, ethnicity and socio-economic status might emerge and spread into the workplace.

A study into barriers existing in academic careers was recently conducted at the University of Oxford which looked at different types of underrepresentation relating to gender, ethnicity, disability, sexual orientation and social class. The findings revealed that individual experiences stemmed through the interplay of more than one of these factors at any given time, therefore promoting the need for further intersectional research into EDI (**Mitra & Dopson, 2024**). However, Engineering UK's strategy (as conveyed in their report covering the 2019–22 period) lacks this significant perspective, overlooking how overlapping identities can exacerbate challenges for individuals from lower socioeconomic backgrounds.

Another factor which must be taken into account is the influence that the COVID-19 pandemic has had on the results and findings of recent studies, warranting the need for new and updated research in a post-pandemic era. The pandemic forced the adoption of flexible working solutions and enhanced technologies to allow researchers to continue their work safely and, most frequently, remotely. It also clearly presented unexpected challenges to productivity, lab-based work, data collection and research in general. EngineeringUK (**2021**) recognises the disruption caused by the pandemic but nonetheless notes the increased visibility of the engineering sector during this period and the positive effects of improved EDI on productivity and innovation. As we move beyond the constraints of COVID-19 equipped with new experiences of flexible working environments, now more than ever it can be argued that EDI strategies should be implemented to the fullest extent to reap the immense benefits they can create for workers themselves as well as the wider industry. The British Science Association's (**2021**) report also supports this view, suggesting that new research can help shed light on the results gathered during the pandemic. This discussion has been in the context of STEM-related organisations in general, but moving forward and emerging from the pandemic, there is a need for a closer look at research/academic institutions as we move into a more contemporary society, as has been argued previously: 'focused research at institutional and sector-level will have the added benefit of nurturing an understanding of social inequalities' (**Clancy & Goastellec, 2007: 151**).

Our literature review underscores the value of integrating qualitative insights to supplement a rigorous survey-based quantitative analysis. The British Science Association's research indicates that there is a significant

amount of quantitative data within the STEM sector, yet a lack of qualitative data (**British Science Association, 2021 Report: 51**). Qualitative research can capture the nuanced experiences of workers in research careers, offering deeper insights into the specific barriers they may face and is therefore essential. However, this does not detract from the usefulness of, and the need to implement accurate and comprehensive, quantitative methodologies. When used effectively these can provide clear evidence for resulting outcomes (**Palid et. al, 2023**). Such a mixed methods approach influenced our methodology, as described below.

Methodology

The study was organised in two phases: an initial survey aiming to define and understand the barriers faced by STEM researchers in pursuing a career in academic research, and a follow-on workshop aiming at providing a safe space for participants to reflect on how their working experience has been affected by these barriers. This paper focuses on the initial survey, where barriers faced by STEM researchers were investigated specifically within the department where this study was conducted – Warwick Manufacturing Group (WMG). The anticipated outcomes from the survey were:

1. Understanding of the commonality and relevance of barriers gathered from the literature and the anecdotal reports received by WMG Research Office;
2. Identification of barriers that have not been captured by the above sources;
3. Recognition of the level of impact of the barriers identified;
4. Identification of potential correlations between certain characteristics of the researchers and the common types of barriers they face.

The identification of barriers in existing literature was conducted using both direct and indirect approaches. Direct approach involved direct reference to barriers reported in the literature, where the barriers were usually obvious and well-defined and with clearly negative impact, such as hostile environments, bullying and harassment in the workplace (**British Science Association 2021: 24, 43**). Indirect approach involved defining the barriers through the authors' own analysis and inference. Such barriers tended to have less obvious correlation with the impact they had caused, and sometimes could only be identified through indirect evidence. For example, the very low number of grant applicants and grant holders who respond that they identify as disabled indicates there may be barriers to people feeling comfortable to respond (**Wellcome Trust, 2021**). As a

further example, a report by a scientific society had found that in some recruitment cases, changing certain selection criteria and recruitment requirements could attract more applicants with a certain minority background (**EngineeringUK 2021: between points 31 and 32**). The underpinning issue here is that the recruitment practice is not inclusive of researchers who are not familiar with it. This could include early career researchers, researchers from a different research background, and researchers who have not received necessary support.

Four macro-areas of barriers for pursuing a successful career in academic research were identified: 1) Isolation and disconnected community, 2) Limited time (for research) and poor timing (for research outcomes and career stability), 3) Limited access to resources, 4) Lack of clarity around job roles, progression and grant capture. The survey also recorded anonymous data concerning (protected) characteristics of the participants to investigate if certain types of barriers are more likely to be associated with certain characteristics. This approach not only inspires more targeted solutions to tackle the barriers, but also addresses the lack of intersectionality in the current literature concerning inclusiveness in STEM. It should be noted that participants were given the option to not disclose their characteristics, in which case their responses to the remaining questions would be excluded from the analysis on the correlation between characteristics and types of barriers.

The survey questions were presented as a mixture of open questions and rating questions. Three open questions were positioned at the beginning asking participants to reflect freely on 1) the barriers to conducting research they had encountered so far, 2) the obstacles that they could envision in proceeding further in their aspirations, 3) the reasons for which they might have thought to abandon a career in academic research. This was done to avoid influencing participants through more direct and specific questions and gave us the chance to gather data concerning barriers that were prima facie perceived by (unprompted) participants as pressing and concerning. Additional open questions were included in each section and at the end to allow participants to expand, clarify or share specific episodes concerning aspects of their experiences. This gave us the chance to capture nuances and details concerning barriers that were already recognised by the research team (through literature and anecdotal reporting) but that could show up in distinctive forms and shapes in the participants' personal experience in WMG. The rating questions were formulated in statements that participants could agree or disagree within a five point scale from 'Strongly agree' to 'Strongly disagree', with an additional 'not applicable' option. This provided the research team with quantitative data that pointed to the most pressing and widespread

barriers experienced by participants making clear which should be addressed urgently.

The survey was distributed to around 200 research-active staff within WMG, among which 44 participants (approximately 20%) fully engaged with the survey. Reponses to open questions primarily yielded qualitative data which was then categorised into the macro-areas described above, with barriers not captured from the literature review highlighted. The rating questions yielded quantitative data, which was analysed in two ways: 1) descriptive statistical analysis on individual questions to assess the commonness and impact of the barriers and 2) bivariate analysis to assess the correlation between personal characteristics and barriers.

A key limitation of the study was the lack of representatives of several minority backgrounds due to the small number of participants, which affected the intersectionality study most. For instance, gender could only be considered on a binary basis (female/male) as no other gender identities were captures in the data, and results related to disabilities, religious views, ethnicity and part-time contracts were inconclusive.

The study received full ethical approval from the University of Warwick's Biomedical and Scientific Research Ethics Committee, reference 80/23-24.

Results and Discussion

This section presents key findings from the survey analysis, organised around the identified macro-areas extracted from the barriers: Time and Timing, Communication and Information, Community and Belonging, and Access to Resources.

Figure 1: Responses ranked by 'Strongly Agree'.

I feel there are unwritten rules in my research environment that I do not understand	40.91
… realistic timing for applying for the following contract to ensure employment continuity	27.27
I feel I am not receiving enough guidance by mentors and senior academics	27.27
I feel that I am not going to progress further in my research career due to lack of clarity of requirements for promotions	27.27
…timing to achieve all required goals, putting pressure on researchers' mental and physical health	27.27
I feel that hidden responsibilities involved in my current position impact on my capacity to dedicate time and efforts to my research	25.00
… realistic timing for applying for follow-on funding	22.73
… realistic timing for mandatory administrative and bureaucratic tasks	20.45
I find it difficult to access information about how to obtain further funding	20.45
…the appropriate amount of time required for conducting research and developing outputs, outcomes and impact	20.45
…caring responsibility for elderly or fragile family members	18.18
… the time needed to acquire necessary transferable skills (e.g. learning a language)	18.18
… realistic timing for teaching duties	18.18
It is unlikely for me to be able to reach full professorship status	18.18
… realistic timing for publications in my field	18.18
I am not sure what I should prioritise to achieve my research and career goals	18.18
I find it difficult to access information about sources of funding	18.18

13 of the top 23 questions ranked by 'Strongly agree' response related to 'Time and Timing'. Time to find the next role, to achieve required goals, to fulfil hidden responsibilities and to apply for further funding were all of concern. However, the 'Time and Timing' category also provided the

majority of neutral responses, indicating that for some this group of barriers are very pervasive but for others there is a level of ambivalence. The barriers of finding the time to create impact cases (neutral responses 31.8%) and finding the time to acquire transferable skills (neutral responses 27.3%) were the most neutral. The first of these may not have seemed relevant to all respondents, particularly if answering within the context of REF (the UK's Research Excellence Framework assessment exercise) which previously has had strict eligibility criteria and for whom those eligible staff form a subset of our survey population. However, when combined with the 'not applicable' responses, this question falls significantly down the ranked list, indicating a true ambivalence to this barrier. 'Impact is defined as the effect or change over time that we can see, demonstrate, measure or capture on different stakeholders.' (**Campillo et al., 2023**). Perhaps instead this type of activity, usually performed over the longer term, does not bring with it the strength of feeling that an inability to complete more immediate and urgent tasks, or the 'latest and loudest' (**Allen, 2017**), do.

There are various tools available to help people analyse their work activities, such as the Eisenhower Matrix which plots tasks on two axes: time (urgency) and importance (strategic alignment to goals) (**Obolensky, 2010**). Studies have shown that people are able to identify and prioritise tasks relatively accurately which either have both or neither of these characteristics but are less able to complete tasks which are important but non-urgent (**Zhu, 2018**).

Kennedy and co-authors (**2022**) suggest 'faculty, like many individuals, have difficulty prioritizing important tasks over those that seem more urgent' but also notes the limitation of such two-dimensional analysis, suggesting that 'in reality the academic environment is more complex'. Peter Drucker has written, 'knowledge workers themselves define what the task is or should be' and that a key component of knowledge work and associated productivity is 'to learn to define quality' (**Drucker, 1999**). Bruce Daisley goes further in The Joy of Work (**2019**), describing the notion of a Victorian mill owner and that style of management, or self-management: 'It's not just that mill owners are bad for morale or that they may get in the way of someone doing their best work. They also make us focus on the wrong end of the productivity equation', referring to presenteeism and other outdated notions of productivity (**Daisley 2019: 61**) which do not necessarily improve either the quantity or quality of output. Neither does the very nature of research, being open-ended, full of uncertainty and with unknown horizons, help this situation.

A further highlighted barrier was time for mandatory administrative and bureaucratic tasks. One could argue that in order to accomplish everything required in a research role these administrative and bureaucratic tasks should be minimised as much as possible, and their mandatory nature should be reviewed on a regular basis. The Government's Workload Reduction Taskforce (**DfE, 2024**) relating to UK school teachers is an example of one such initiative.

Certainly, the depth of feeling by our respondents within the theme of 'Time and Timing' would suggest that more guidance and support to help colleagues truly identify 'effective' tasks (important but non-urgent) and find ways to complete these to the detriment of 'distractions' (non-important but urgent) (**Covey, 2004**). Implementing such guidance and support might lead to increased agency, removing some barriers preventing researchers from successfully pursuing the careers they love, and improve overall mental health in the process (**Davidson, 2005**).

Communication and information: Unwritten rules and missing clarity

Figure 2: Responses to Communication and Information.

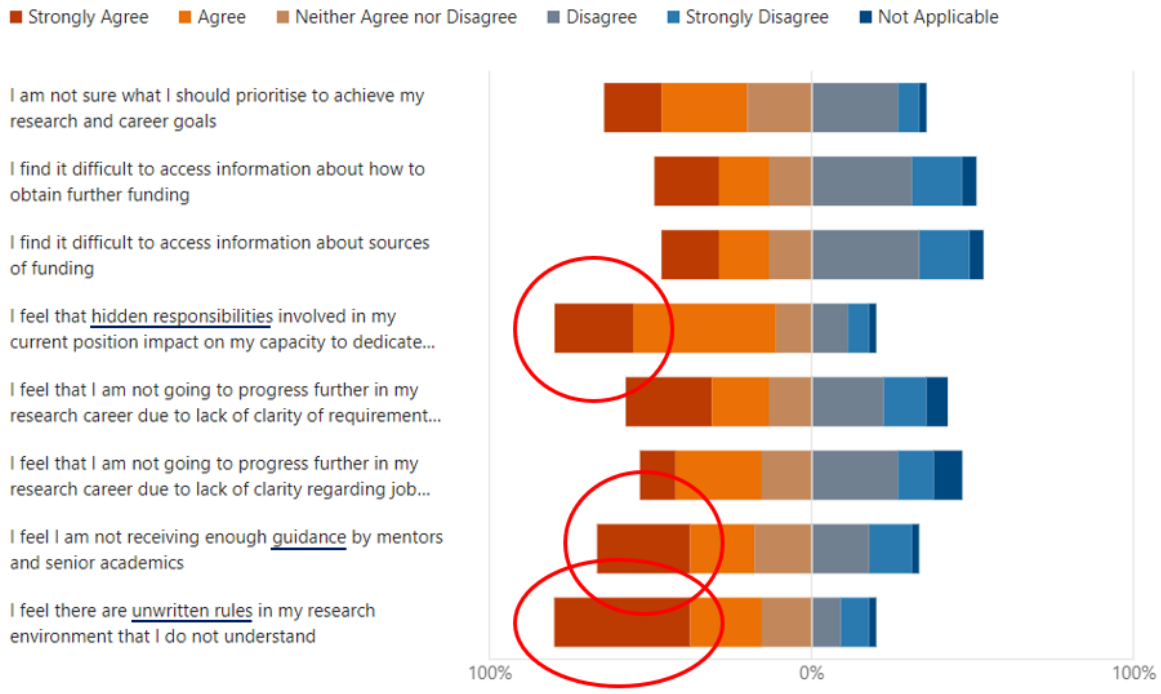
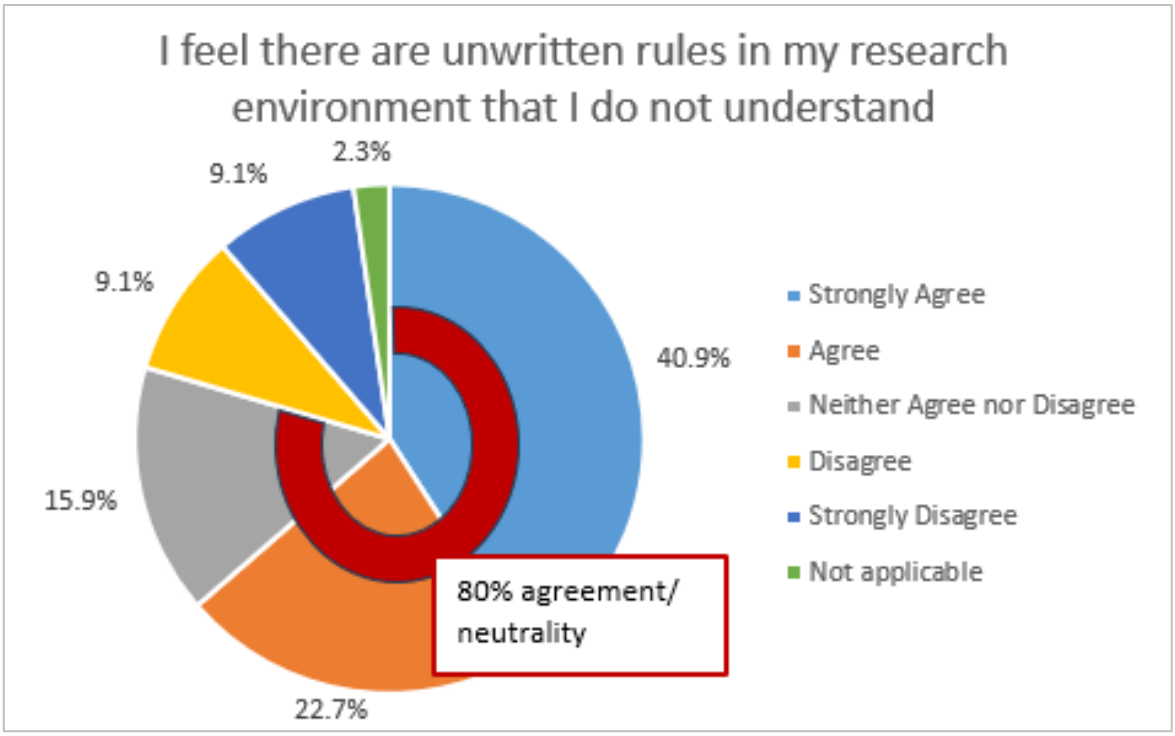


Figure 3: Unwritten rules responses.



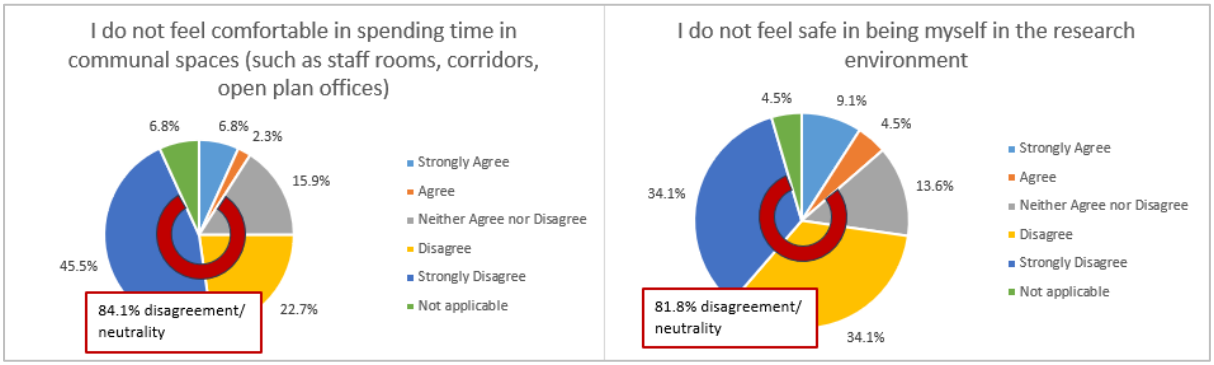
41% of respondents strongly agreed with the statement 'I feel there are unwritten rules in my research environment that I do not understand', the statement with the highest level of strong agreement of all the questions. This was followed by strength of feeling around insufficient time to secure employment continuity, to achieve all required goals, having clarity on what those goals are, and receiving sufficient guidance and mentoring. Hidden responsibilities and time to secure follow-on funding, linking back to secure employment, were also high in the list (**see Figure 1**). These areas remained consistently high when incorporating the 'Agree' category. When including the neutrality option, these were joined by worries over unwritten rules. According to the findings, early-career researchers feel particularly disadvantaged due to the opacity of institutional knowledge, and insufficient guidance was felt strongly across all career stages except the most experienced category.

Communication and belonging: Strong feelings, divided views

On the other hand, negative aspects of community had the most instances of strong disagreement. Respondents did not feel difficulties communicating effectively with co-workers (77.3%), did not have their abilities and competence questioned (72.7%), did not feel uncomfortable in communal spaces (68.2%), nor in being themselves in the research environment (68.2%). When also considering the neutral responses, these latter two questions increased to 84.1% and 81.8% respectively, which does however leave an unacceptable 9.1% and 13.6% respectively feeling

as though they were not welcomed in communal spaces and were not able to be themselves at work.

Figure 4: Strongest disagreement and neutrality.



When considering the responses with the strongest feeling behind them in one direction or another, for example those with the smallest number of neutral or not applicable responses, nine of the top eleven are from within the overall theme of community and belonging: clearly an area that provokes strong feeling and emotion for many of our respondents. Some of the free text comments reached as far down through Maslow's hierarchy of needs (**Maslow, 1943**) as the third level for love or belonging, with many comments existing in the esteem category around respect by others, self-esteem, status and recognition.

Belongingness has been described as 'the universal need to form and maintain positive, stable interpersonal relationships' with researchers suggesting a growth orientation aimed at interpersonal actualisation gives greater intra- and inter-personal psychological functioning compared to a deficit-reduction orientation, aimed at interpersonal repair (**Lavigne et al., 2011**). Indeed, Baumeister and Leary (**1995**) state that the need to belong is so powerful and pervasive that 'people form social attachments readily under most conditions and resist the dissolution of existing bonds'. This is a fundamental need, and they further posit that much of human behaviour is in service of belongingness, without which there is not much value.

In terms of organisational psychology, feelings of belonging to a workplace culture inherently increase our internal self-esteem and also can increase engagement, motivation and productivity at work (**Maria et al, 2024**), making this a factor which arguably should receive more attention from institutions. Holly Branson (**2023**) agrees: 'To be a truly purpose-led business (and therefore a successful one!) your people and their wellbeing should be at the heart of everything you do. The issue comes when leaders don't actually know who their people are'.

One way to increase attention on this facet is to increase the frequency and depth of conversation. Sigal Barsade has championed the notion that we should talk more about friendship, belonging and love at work, encouraging 'companionate love' in the workplace. 'Employees do not leave their humanity at the door when they walk into an organisation', and recognising this can lead to benefits such as greater job satisfaction, commitment to the organisation and accountability (**Barsade, 2015**). Standards are highest when we feel a sense of close affiliation with our group, and so as well as improved quality this is also the situation when the 'emotional contagion' of a supportive culture can manifest most easily.

Looking at those working in STEM, it is critical to understand the influences around what 'STEM belonging' means from the feedback from diverse researchers in order to ensure equity. Belonging-uncertainty is defined as the quality of social relationships within an academic setting and can manifest as the belief that 'people like me do not belong here' (**Dost, 2024: 11-12**). As mentioned previously, when the survey statements were ranked for polarisation, the majority were from the belonging and community category, such as 'I feel that my research environment is not inclusive' with 11.36% of respondents stating they Strongly Agreed, against 34.09% who Strongly Disagreed, and 'I perceive the research environment as hostile and unwelcoming' with 13.64% who Strongly Agreed and 27.27% who Strongly Disagreed. Another highly polarised response was for the statement 'I find it difficult to access information about how to obtain further funding', where 22.73% strongly agreed, whilst 15.91% strongly disagreed. Some polar differences were particularly noticeable around the identity characteristics of gender, ethnicity and career stage, further discussed below where we considered an intersectional lens.

Access to resources: Well-stocked, available

It was good to see that the University's excellent library provision was recognised, with 52% of respondents strongly disagreeing that access to literature presented a barrier for them pursuing research, and this increased to 89% when including the 'disagree' and 'neutral' responses. In our specific context few respondents cited issues with resources as barriers to progression.

Intersectional inequalities: Career stage and gender

One way of considering intersectionality is that of a metaphor for understanding the ways that multiple forms of inequality or disadvantage sometimes compound themselves and create obstacles that often are not understood among conventional ways of thinking (**Aiston & Walraven, 2024**). Within the workplace, intersectional inequalities exert in the career

progression experiences of women across different ethnicities in the UK (**Kele et. al, 2022**).

When discussing 'ethnicity + career stage + gender + intersectionality in STEM', it refers to the complex interplay between a person's ethnic background, current career level, gender, and how these factors overlap to create unique experiences and disparities within STEM fields (**Sparks et al, 2021**).

With regard to certain identity considerations, there were some polar differences in responses as a function of gender and significant correlations were found during data analysis with the following survey statements:

(i) I feel that my research environment is not inclusive.

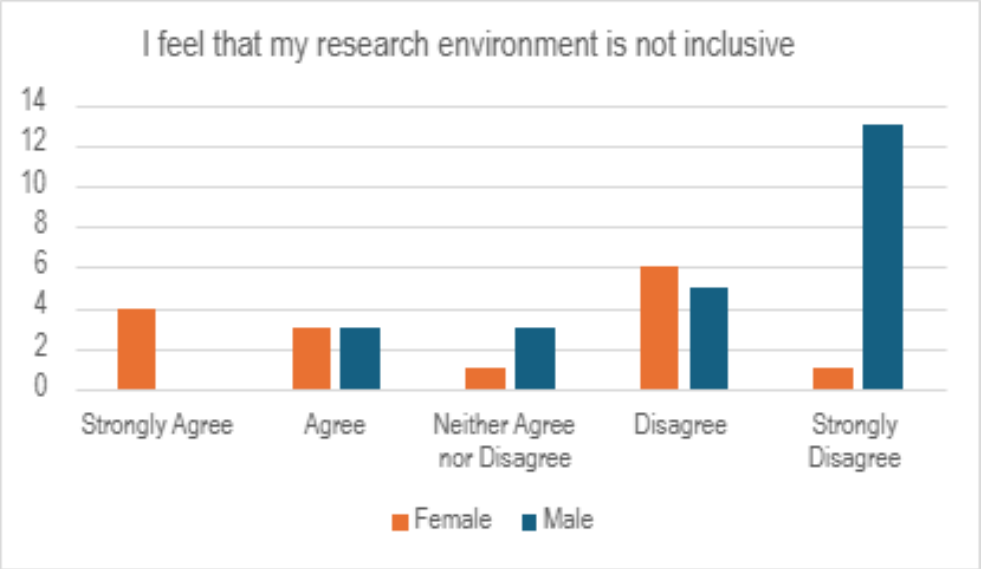
(ii) I feel unsafe while conducting research because of needing a second source of income to cover my living costs.

(iii) I feel there are unwritten rules in my research environment that I do not understand.

(iv) I feel that I am not taken seriously in my workplace.

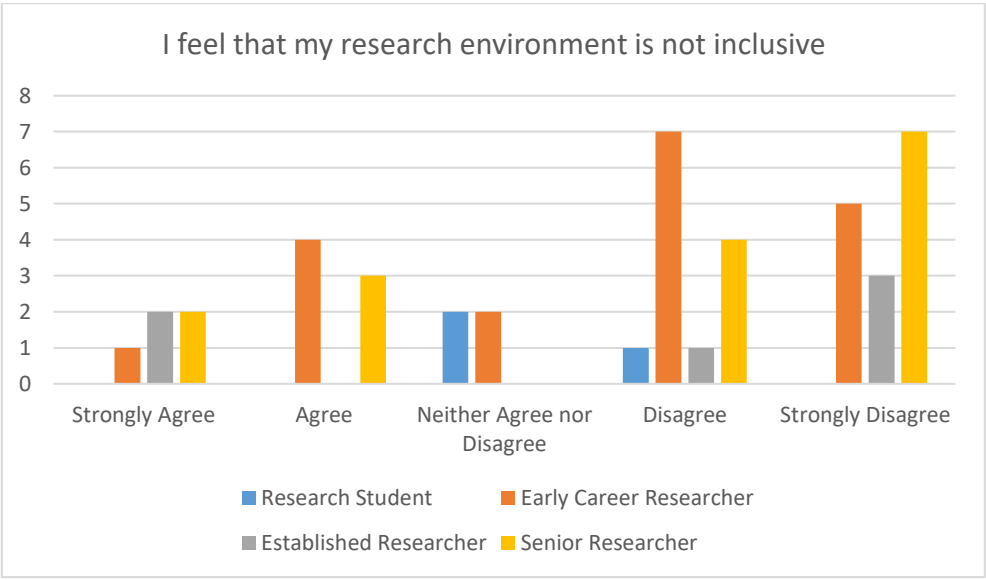
Statement (i) was responded to significantly differently between male and female participants, with 54% of the male responders strongly disagreeing compared with 4% of female responders. 27% of females strongly agreed with this statement with no male responses submitted to this category. These responses came from a range of career stages from early career to established research staff. Interestingly similar number of males and females disagreed and agreed. However, it would appear that women were more likely to relate to this statement, with a p-value for the chi-square test of 0.0071, significantly less than the typical alpha value of 0.05 suggesting that there is a significant dependence between the two variables of gender and opinion. Within the free-text box, multiple female respondents commented that they could not see anyone in leadership 'like them', and some also raised concerns that their interdisciplinary background, including the social sciences, was not valued within a STEM context.

Figure 5: Gender responses to statement (i).



This statement also showed the strongest dependence across career stage, with a chi-squared p-value of 0.04495. These findings form part of a pattern where women and early career researchers were consistently more likely to report barriers, particularly those rooted in culture, communication, and inclusion.

Figure 6: Career stage responses to statement (i).



With regards to statement (ii) concerning the need for a second income (**see Figure 7**), the largest negative response came from male staff with 17 of the 23 male respondents disagreeing or remaining neutral. None of the female respondents selected Strongly Disagree at all. Statistical significance between female respondents and agreement was confirmed by a chi-squared test providing a p-value of 0.04776 when considering just the 5 opinion options as per Figure 7 below, which reduced even further

to 0.01055 when also including the Not Applicable answers, indicating a strong relationship. Across career stages, Research Students were wholly in agreement with this statement, whilst Established Researchers were either neutral or in strong disagreement. Within the comments there were references to the particular struggles of single parents, and also the plight of PhD students and the stipend levels which concurred with the quantitative data.

Figure 7: Gender responses to statement (ii).

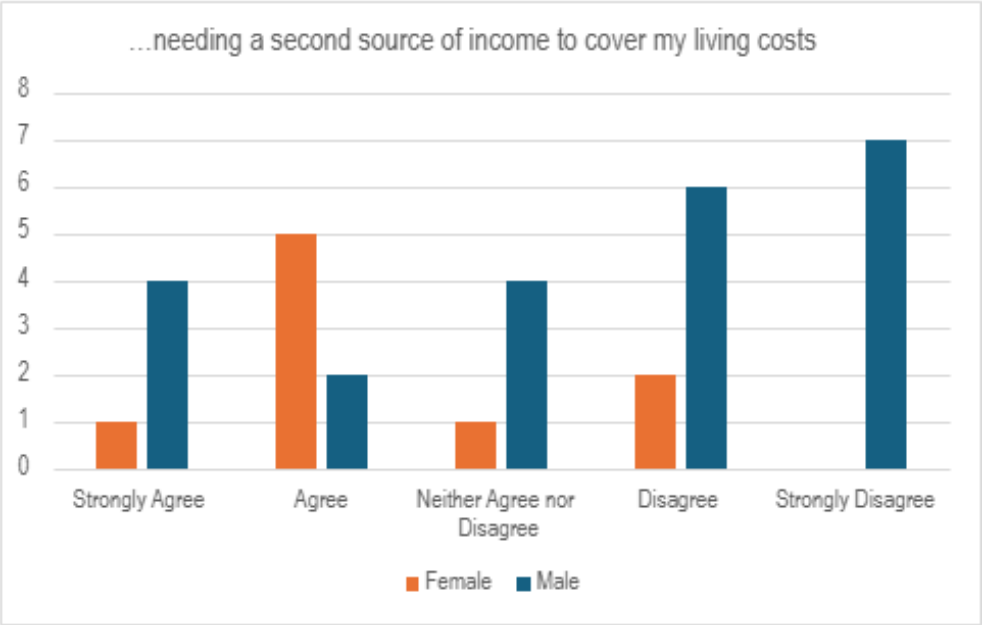
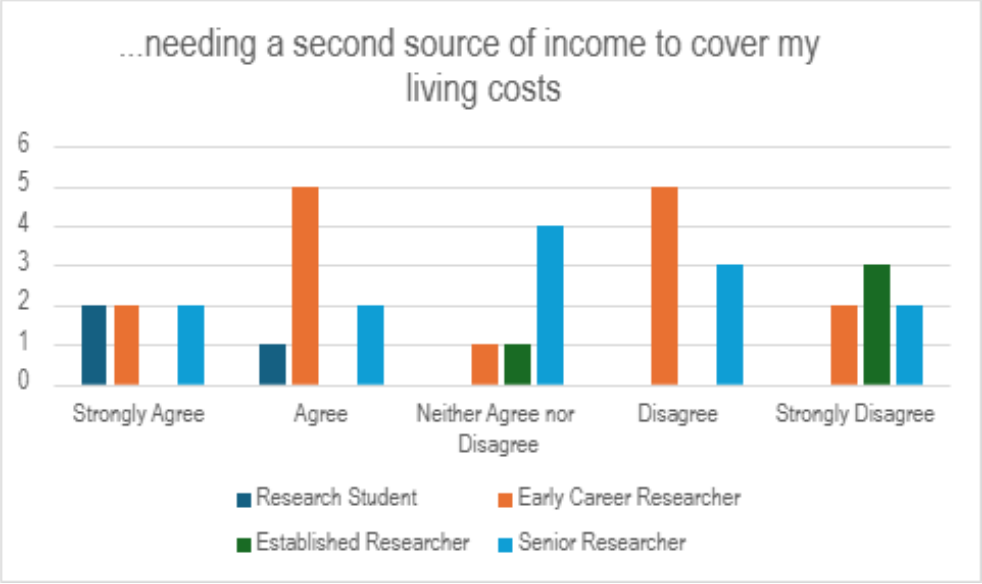


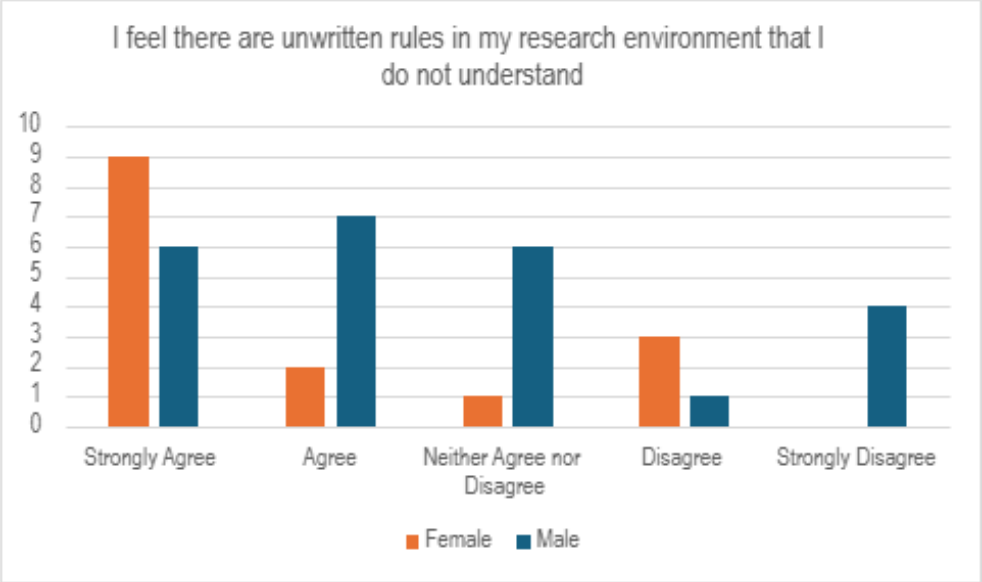
Figure 8: Career stage responses to statement (ii).



Statement (iii) around unwritten rules drew a large positive response from female staff, with 60% strongly agreeing with this statement, compared with 25% of male responses respectively. Male responses were quite evenly spread across agreeing or disagreeing, but it was only male

participants who strongly disagreed with this statement (ca. 16%). The p-value from the chi-squared test was 0.03381, less than the 0.05 alpha value indicating dependence between gender and opinion for this statement. Comments within the relevant free-text section mention clarity and subjectivity around probation (tenure requirements) and promotion, also the quality of onboarding when joining the organisation and clarity around the roles and responsibilities of the different support teams, with a suggestion that those who understand how to utilise these support structures the best will progress most rapidly.

Figure 9: Gender responses to statement (iii).



With regards to statement (iv) around being taken seriously in the workplace, the majority of males disagreed or strongly disagreed (75% of the male response), with quite an even spread of female agreement and disagreement. Responders selecting disagree options came from both early and established career stages, and again there is a clear correlation between gender and opinion on this statement, with a p-value of 0.02367, less than an alpha value of 0.05, hence the data here suggest that females within our study felt they were not taken seriously more than males did (**see Figure 10**). Additionally, participants earlier in their career did not show so much agreement, and more senior researchers tended towards disagreement, however we were unable to verify dependence between career stage and opinion.

Some participants explored the nuances of the different communities they were a part of and the culture within these, with one stating: 'There is a big difference between Team, Network, and Community'. Participants commented on the variations between individual personalities and how closely they are situated within particular individuals' locus of control, particularly within the decision-making hierarchy. There were also

distinctions made between how participants view their professional identities and networks, with one responder stating: 'I feel well connected to 'my' team/network/community - just that 'my' team/network/community is not what I would see the group I am working in as being part of'. Other participants discussed how their colleagues, supervisors and 'the system' appeared to value research project income over outputs or outcomes which in some cases did not align with their own values, leading them to be taken less seriously. In other cases participants bemoaned the constant race for funding and the time this takes, whereby having a strong track record of funding was considered 'necessary' to be taken seriously, but this placed a lot of pressure on work life.

Figure 10: Gender responses to statement (iv).

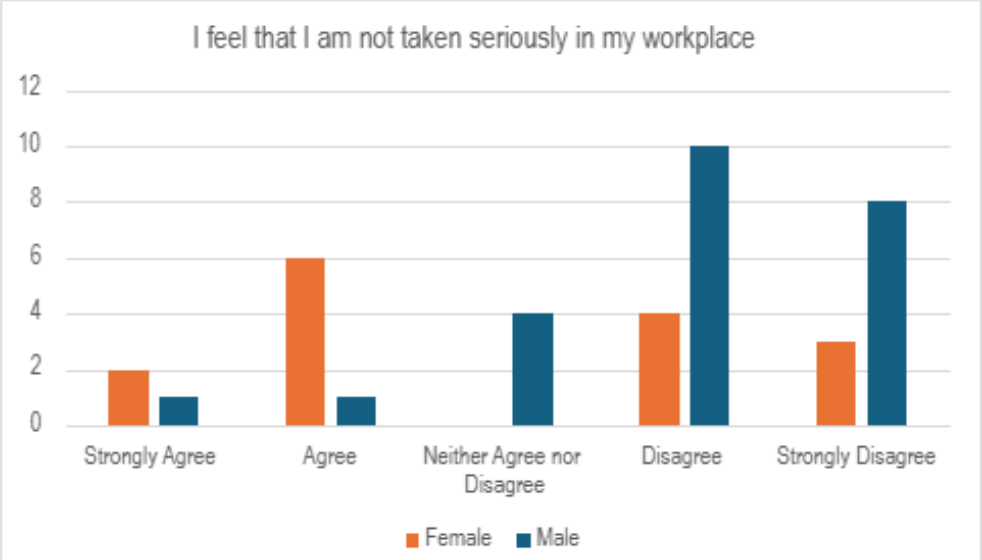
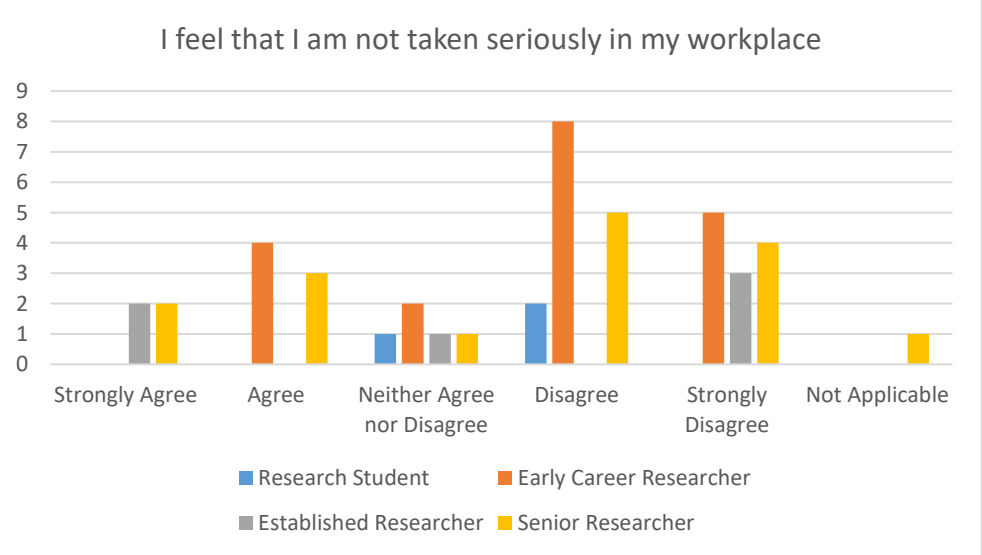


Figure 11: Career stage responses to statement (iv).



Of all the statements within the survey, the least applicable specifically cited barriers related to Right to Work, barriers for those not currently affiliated to the University, and maternity leave and caring responsibilities. This is not to say that these categories are not important and present significant issues for those within these identity groups, only that the majority of our survey population did not identify with these issues. For those who do experience these barriers, further details could be gleaned from the free text comments and identity characteristics.

For example, those who faced issues with their Right to Work (18.2% of our respondents answered 'Agree' or 'Strongly Agree') come from the full range of career stages, were equally split between permanent and fixed term contracts, had been in those roles across the full range of options from 'less than 6 months' up to 'more than 5 years', had both moved institution and also stayed at the same institution and in some cases stayed within the same department and even research group (but this was decidedly unconnected to length of service), and were a mix of ages, genders, religions and marital statuses. The only unifying feature was that all of these respondents stated they spoke at least one other language in addition to English. Respondents mentioned feeling unsafe, of the additional uncertainty, and made suggestions such as having diverse interview panels and 'buddies' to help colleagues through the difficult processes and support during these times of mental strain (25% of these respondents disclosed a mental health condition).

As another example, those who identified as having caring responsibilities (of any kind) were more likely to struggle with aspects of time and timing, but not universally. However, some respondents disclosed that they had left the sector whilst shouldering those caring responsibilities as research and/or academic careers 'were not compatible' with such duties, although they had now returned. Clearly the consequences of some barrier combinations are more than just uncomfortable or irksome, but can fundamentally change how a person chooses to spend large periods of their working life.

Conclusion

The barrier categories of Time & Timing and Communication and Information were most prevalent in our survey responses. Unwritten rules, hidden responsibilities and insufficient guidance all contributed to respondents feeling hampered to pursue a career in STEM research in our organisation. There were concerns over employment continuity, and opinions around belonging and community were polarised.

Our findings showed that respondents who identified as women and as early career researchers were more likely to feel the environment was less inclusive at our institution, identifying key contributing factors such as needing to work a second job and struggling with unwritten rules. Our study of intersectionality was limited due to the number of responses. With only 44 responses to analyse, this meant that there were characteristics which were not present in our respondent group, or were in such low numbers as to make any possible analysis statistically invalid. The 20% response rate was lower than envisioned, and on reflection this may have been due to the timing of the survey being close to other information requests. In the future, we would like to delve into intersectionality aspects further in the focus group exercise, to consider in more detail how the key barriers identified in this survey manifest in daily working life for members of our organisation.

We benefitted from respondents' thoughts on community identity and suggestions such as mentoring to help clarify requirements. We would like to further explore the critical role of line manager in this regard, as well as practical solutions to reduce administration and overwhelm.

Enhanced mentoring, clearer communication, and proactive inclusion strategies make up just some of the clear-cut interventions that can improve equity, wellbeing, and performance across research communities. Systemic barriers such as the prevalence of fixed-term contracts and competitive funding will need a joined-up approach to find a solution that does not make the situation worse for members of the research community who are already facing significant difficulties. We are excited to continue to work with colleagues internationally to improve research culture and the opportunities, sense of belonging, and quality of work life, for those who work within it.

Acknowledgements

We would like to acknowledge the Enhancing Research Culture fund from University of Warwick's National Centre for Research Culture, and also WMG's Summer Internship scheme. Many thanks to Pranav Jain for his expertise and support on Excel, statistics and data analysis.

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Dr Melanie Loveridge is an Associate Professor in WMG, where she has worked since 2014. For the last 17 years her research has focused on energy storage materials for Li-ion battery technology. This has spanned multi-scale cell form factors and included 6 years as a specialist within a spin-out company from Imperial College. At WMG her research focusses on both material development, electrochemical testing and advanced characterisation. Since 2017 Mel has led the Battery Forensic activities, with >45 publications in Q1 journals. Mel is a co-investigator of the Faraday Institution's SafeBatt project and spent several years as an investigator with The Graphene Flagship.

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Previously Chief Engineer responsible for part of the East Midlands electricity distribution network, Sarah Wilson now supports academics and researchers in WMG, one of two engineering departments at University of Warwick. From clarifying research strategies to finding funding to enact these, through to considering publication strategies and capturing arising impact from projects, Sarah leads a small dynamic team to enable the academic research lifecycle. A particular interest is in the career development of colleagues, and Sarah takes an active part in the department's mentoring, promotions and tenure processes as well as managing the fellowship pipeline and international activities.

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To cite this article:

Lorenzi, G., Zaidi, A., Loveridge, M., Qian, C., & Wilson, S., Breaking Bad Barriers to Pursuing Research: A concordat to research equity (part 1). *Exchanges: The Interdisciplinary Research Journal*, 12(3), 72-97. Available at: https://doi.org/10.31273/eirj.v12i3.1855.