From care inside the laboratory to the world beyond it: A multispecies ethnography of TB science towards growing a decolonised science in South Africa

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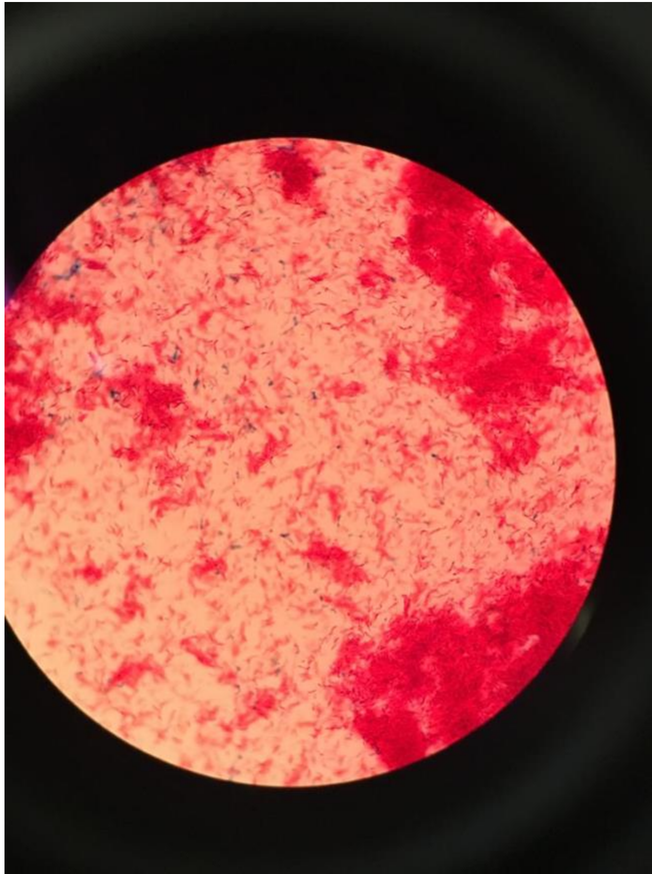

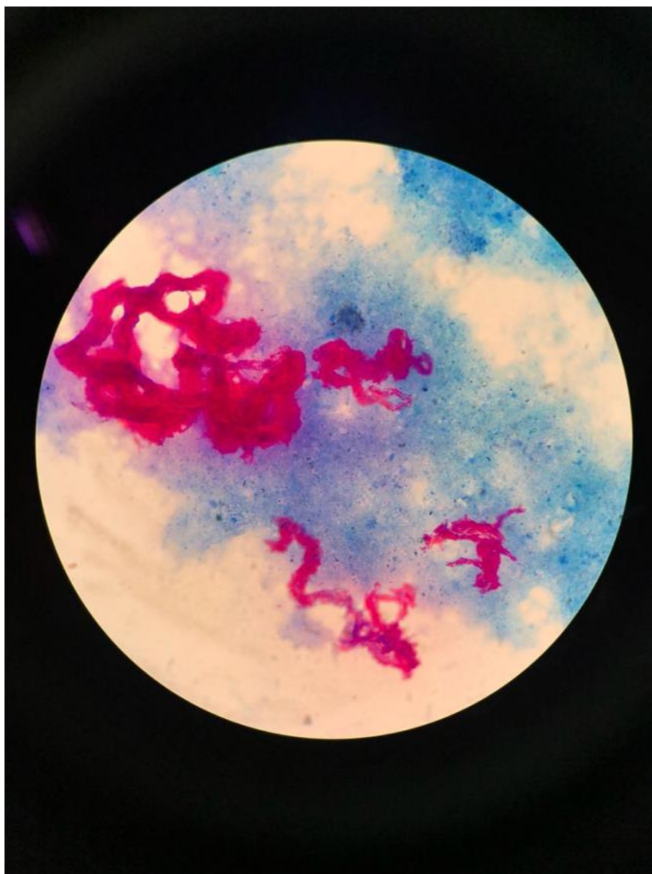

Images 1 and 2: **Ziehl-Neelsen (ZN) stains of *Mycobacterium bovis*, as seen through a microscope.** ZN stains are a form of smear microscopy often used to detect and diagnose Tuberculosis (TB). Samples are placed onto glass slides and stained using the ZN technique, which stains the bacteria a pinky-red colour. I was told by a participant that they are still one of the main diagnostic tools in the global South because they are relatively inexpensive. These photos were taken during one of Alison's lion diagnostic tests. The view through the microscope shows the microscopic rod-shaped *Mycobacterium bovis*, which looks identical to *Mycobacterium tuberculosis* (*Mtb*). The bacteria clump together, forming dense pockets of bacilli (see Image 1) and serpentine-like structures (see Image 2). Photos courtesy of Alison.

ABSTRACT

This anthropological research began with curiosity about human relationships with microbes. Inside the contained environment of a Biosafety Level 3 laboratory at a South African university-based tuberculosis research division, the fieldwork focused on the relationships between scientists and *Mycobacterium tuberculosis* – the pathogenic bacterium that causes the disease tuberculosis (TB). These deadly bacteria were cared for and nurtured by women scientists. This care extended to the cells and various species with which they worked. Moreover, this care moved beyond the scope of their immediate scientific research projects and well beyond the laboratory. Care was also central to how the participants conducted their scientific research and themselves in the world. This long-term, qualitative ethnographic research weaves together many layers of care in biomedical scientific research, highlighting that scientific research is a deeply personal, caring and subjective practice. The natural and the social are not – and can never be – mutually exclusive. Boundaries between mind/body, subject/object, human/nonhuman, researcher/researched, subjectivity/objectivity and science/society are porous. Acutely aware of the socio-political moment in which this research was embedded, these findings are put into conversation with South African student calls to decolonise science that emerged alongside the #RhodesMustFall student movement. In particular, the focus is on a 2016 meeting about decolonising science at the University of Cape Town where students argued for connection between the university and the community, science and society and the world of academia and the world of Africans. Implicit was the need for science to be relevant to Africans and deeply complex African social formations and problems. The care by women scientists that was observed inside the laboratory and beyond it speaks volumes to cultivating a more caring science and caring institutions of science that connect the laboratory to the world in which it exists in meaningful, relevant and impactful ways. I demonstrate how the participants embodied a decolonised science, and that what they cared about and how they acted upon those cares could serve as important guides for decolonising science and scientific institutions. This research provides important contributions to the field of science and technology studies (STS), to anthropological research on TB and to the conversation on decolonising science in South Africa.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

ABSTRACT **4**
ACKNOWLEDGEMENTS **5**
TABLE OF CONTENTS **7**
TABLE OF IMAGES **9**
INTRODUCTION **10**
FROM FREEZER STOCKS TO STARTER CULTURES 10
OVERVIEW OF FIELDWORK, METHODS AND PARTICIPANTS 13
MORE THAN HUMAN RESEARCH 16
MY PARTICIPANTS' SCIENTIFIC RESEARCH 17
BECOMING AVAILABLE TO CARE 19
WEAVING: STYLE, STRUCTURE, THINKING 22
WEAVING AS A MULTISPECIES AND DECOLONIAL APPROACH 25
WEAVING RACE 30
WEAVING A FRAMEWORK FOR DECOLONISING SCIENCE 32
THESIS OUTLINE 33
CHAPTER 1 — WEAVING METHODOLOGY AND ETHICS: AN ARGUMENT FOR SLOWNESS AND PATIENCE **40**
"WHAT YOU SEE BLOCKS YOUR SIGHT": MY MATTERS OF CONCERN 40
TEMPORALITY AND IN-BETWEEN-METHODOLOGY 45
TIMESCAPES, CARE TIME, SCIENTIFIC TIME 49
OPERATING DIFFERENTLY: CARE TIME, PATIENCE AND DISRUPTION 53
SLOW THINKING, SLOW RESEARCH, IN-BETWEEN THINKING 54
GENDERED TIME AND TEMPORALITIES: THE PACE OF WOMEN'S CAREERS 56
SLOW DOWN: AN ARGUMENT FOR SLOW SCIENCE 67
TEMPORALITY AND SLOW RESEARCH 70
CHAPTER 2 — THINKING WITH CARE: CARE AND SCIENCE IN MORE THAN HUMAN WORLDS **73**
ON CARE: GROWTH, LIFE AND BABIES 74
CARE AS *DOING* 79
RELATIONALITY, MUTUALITY AND DEPENDENCY 80
CARE, KILLING, VIOLENCE AND PAIN: RECLAIMING CARE FROM IDEALISED MEANINGS 82
KILLING AND VIOLENCE IN CARE LITERATURE 88
FROM MATTERS OF GENDER TO MATTERS OF CARE 90

CONTAINING CARE: CARE AS DISRUPTIVE 97
DO SCIENTISTS ACTUALLY CARE? 98
IMAGINING CARE'S POSSIBILITIES FOR SCIENCE 101
CHAPTER 3 — SCIENCE AND THE BODY, AND THE BODY OF SCIENCE 104
"BEING A SCIENTIST IS USING YOUR WHOLE BODY": SENSING AND KNOWING 105
A QUICK INTERJECTION: SHATTERING PERCEPTIONS OF SCIENTISTS 112
BACK TO THE SENSES 113
SENSING AND KNOWING: EMBODIED KNOWLEDGE 115
"WHY DID THE SCIENTIST CHOOSE *THAT* THING?": ALISON, MERLEAU-PONTY AND UNPACKING SCIENTIFIC OBJECTIVITY 117
"LOOKING FOR ONE SPECIFIC SEED": FROM MATTERS OF FACT TO MATTERS OF CONCERN 120
"BACK OFF, MAN… I'M A SCIENTIST": SCIENTISM 123
SCIENCE IS MESSY AND "IMPERFECT": "FLITTING IN AND OUT" 124
PERSONAL CONCERNS 128
CHAPTER 4 — POROUS BOUNDARIES: TOUCHING, BEING TOUCHED AND BEING IN TOUCH 130
"IT'S LIKE SPLASHING COLD WATER ON YOU": NARRATIVES OF ENTANGLEMENT 132
"THAT MOMENT WAS LIKE THIS CRITICAL TURNING POINT IN HOW I VIEWED MY RESEARCH AS A CLINICAL RESEARCHER": TOUCHING AND FEELING 138
WHAT HAPPENS IN TOUCH? 144
THE IMPORTANCE OF TOUCH AND CONNECTION: SOME THOUGHTS 146
CHAPTER 5 — WHAT DO SCIENTISTS CARE ABOUT? WHAT MATTERS? 148
"IT'S VERY HARD NOT TO GET EMOTIONALLY INVOLVED": SCIENCE IS PERSONAL 150
"OH MY GOD, I DON'T HAVE ENERGY FOR THAT!": PUBLISH, PUBLISH, PUBLISH 151
COLLABORATION VS THE LONE RANGER: COMPETITION, GREED, SELFISHNESS, CARE FOR CAREERS 155
"I'M STRONG IN THE LAB": BASIC SCIENCE MATTERS 158
THE ENVIRONMENT MATTERS 161
(FOREIGN) AFRICAN STUDENTS MATTER 166
COMMUNITY MATTERS 171
HAVING A LIFE MATTERS 173
"TO NOT JUST STAY IN THE LAB": IMPACT AND RELEVANCE 175
CHAPTER 6 — MUST SCIENCE FALL? AN ARGUMENT FOR GROWING A DECOLONIAL SCIENCE 177

A BRIEF INTRODUCTION TO THE #MUSTFALL MOVEMENT 177
THE COLONIAL UNIVERSITY #MUSTFALL 179
#SCIENCEMUSTFALL 180
“THERE IS NO ANCESTORS, AND THAT’S MY WHOLE BELIEF” 186
“WHAT ABOUT AFRICAN PROBLEMS?”: THE CALL FOR RELEVANT SCIENCE IN SOUTH AFRICA 189
FLOW AND MOVEMENT 195
GROWING A RELEVANT SCIENCE, GROWING A DECOLONISED SCIENCE, GROWING A CARING SCIENCE 197
THE SCIENTISTS WALK MORE SLOWLY: AN INCOMPLETE CONCLUSION 200
APPENDIX A — THE SLOW SCIENCE MANIFESTO 206
APPENDIX B — *THE MUSHROOM HUNTERS* BY NEIL GAIMAN 207
REFERENCES 209

TABLE OF IMAGES

IMAGES 1 & 2: Ziehl-Neelsen (ZN) stains of *Mycobacterium bovis*, as seen through a microscope 3
IMAGE 3: Gallery view of the art exhibition 15
IMAGE 4: Sociable weaver (Philetairus socius) nests 26
IMAGE 5: A photo of Alison’s stained slides 107
IMAGE 6: A Ziehl-Neelsen (ZN) stain, as seen through a microscope 108
IMAGE 7: Exhibition display of Mycobacteria Growth Indicator Tubes (MGITs) 159
IMAGE 8: Exhibition display of the GeneXpert MTB/RIF 160
IMAGE 9: Exhibition display of a microscope 160
IMAGE 10: Exhibition display of liquids in bottles to represent the DNA extraction process 160

INTRODUCTION

FROM FREEZER STOCKS TO STARTER CULTURES

Many of the experiments that I observed inside the laboratory began with a starter culture. Bacteria were grown from a freezer stock into a large population known as a starter culture. The starter culture was then used to grow even more bacteria to be used in scientific experiments and protocols. Outlined in this introduction is my "freezer stock" that I grew into the starter culture of this research. The freezer stock of this research project was fundamental to its growth, just as the media was to the happy and thriving cells and bacteria inside the culture flasks that I looked at on most days during my fieldwork[1]. If ever there was a time that highlighted the inseparability of humans with the myriad of microbes, species and ecosystems that make up this world, it is now in the time of COVID-19. My anthropological research on microbes and infectious disease, however, started six years ago when I began conducting fieldwork with biomedical scientists at the start of my postgraduate studies. I was interested in the social life of *Mycobacterium tuberculosis* (*Mtb*) – the mycobacteria that causes the disease tuberculosis (TB) – inside the laboratory, and human (scientist) relationships with it[2]. The research was propelled by two intentions. Firstly, I wanted to contribute to the anthropological research on TB in South Africa, but from a different point of view[3]. Secondly,

[1] "Media" refers to the liquid used to provide all the nutrients needed for the bacteria and cells to grow.

[2] I use *Mycobacterium tuberculosis*, *Mtb*, bacteria and TB bacteria interchangeably. My participants used these terms interchangeably as well. "TB" – although it refers to the *disease* – was sometimes used by my participants to describe to the bacteria too. These terms all refer to *Mycobacterium tuberculosis*, the bacteria that causes the disease, tuberculosis (TB).

[3] The *Social Markers of TB* project led by Dr Helen Macdonald at the University of Cape Town contributes important anthropological research to understanding tuberculosis, as well as to the field of medical anthropology. Research under this project and beyond it includes, but is not limited to research by Laura Winterton (2010; 2013); Kate Abney (2011; 2014; 2018; 2020); Justin Dixon (2012; 2013; 2017); Carina Truyts (2013); Mutsawashe Mutendi (2014; 2017); Macdonald, Abney, Amber Abrams and Truyts (2016); Peter du Plessis (2017); Macdonald and Mutendi (2017); Anna Versfeld (2017); Dixon and Michèle Tameris (2018a; 2018b); and Mutendi and Macdonald (2018). A special issue titled, "Globalised tuberculosis control in local worlds" edited by Macdonald and Dixon and published in the journal *Anthropology Southern Africa* (2018) and the book *Understanding Tuberculosis and its Control: Anthropological and Ethnographic Approaches* (2020) edited by Helen Macdonald and Ian Harper are some of the most recent examples of research coming out of this field. Other social research in the TB field that has been interested in different points of view and has been in discussion with these works includes work done by the South African Tuberculosis Vaccine Initiative (SATVI) and the South African Medical Research Council (SAMRC) (Abrams, Siegfried & Geldenhuys, 2011; Schmidt, Abrams & Tameris, 2016).

I wanted to contribute to the multispecies turn in anthropology specifically and the humanities more generally.

South Africa is ranked in the top 30 "high TB burden countries" in the world (WHO, 2021). Compounding the burden, is the interrelationship between HIV and TB (The First National TB Prevalence Survey, 2018: 6). In 2018, TB prevalence was 737 per 100 000 population (The First National TB Prevalence Survey, 2018: 17). In 2019, there were 360 000 new TB cases compared to 301 000 the previous year (Wong & Grant, 2021). TB is one of the leading infectious disease causes of mortality in South Africa today (The First National TB Prevalence Survey, 2018: 23; TBFACTS.ORG, 2021; Wong & Grant, 2021). The World Health Organization's Global Tuberculosis Report for 2021, states that "The COVID-19 pandemic has reversed years of progress in providing essential TB services and reducing TB disease burden" (WHO, 2021: 1). Research also shows a large decrease in numbers of South Africans testing for TB and accessing TB treatment since the COVID-19 lockdown (Pillay et al., 2021:1; Wong & Grant, 2021). This could have devastating consequences, amplifying the burden of TB in this country. In addition, TB in South Africa must be understood as inseparable from poverty, race, and a brutal historical legacy that continues to aggravate the burden of disease. Although TB can infect anyone who breathes – as TB survivor and activist Dr Zolelwa Sifumba said in her presentation at the 5th South African TB Conference in 2018 – South Africa's current TB epidemic is juxtaposed against the historical legacy of colonialism, cheap migrant labour and mining (Coovadia et al., 2009). The TB epidemic was exacerbated by and continued under apartheid rule (ibid)[4]. The impact of this, which has direct correlation to socio-economic status as a result of apartheid's structuring, is that TB disproportionately affects South Africa's black and coloured populations (see Bendavid et al., 2017).

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[4]Apartheid was a brutal project of systematic racial classification, segregation and oppression in South Africa. It was initiated and violently enforced by the all-white ruling National Party in 1948. Under the Population Registration Act of 1950, the South African population was classified into the racial categories "White," "African/Black," "Coloured" and "Asian/Indian." The racist ideology behind the apartheid project was centred around the supremacy of white South Africans and the oppression of South Africa's non-white population. As such, the National Party believed that South Africa's various racial groups should remain *apart* in all aspects of life and various legislature such as the Group Areas Act of 1950 was used to enforce this. The lives and opportunities of black, coloured and Indian South Africans were severely curtailed to keep the power and wealth in the hands of the country's white minority. Although apartheid came to a formal end in 1994, the legacy of apartheid lives on, with a noticeable link between socio-economic status and race in South Africa today. Racial politics still permeate South African society and apartheid's racial categories are still in common use.

Sensitive to this history, I struggled to find my place in the emerging anthropological TB research. As a white, privileged, middle-class South African, I was deeply aware of writing about a disease that is “usually depicted as a disease of poor patients” (Kehr, 2016: 379). As an anthropologist working in the field of TB, I inherit this history. Writing about inheriting histories, Donna Haraway makes the point, “Somehow, this fraught history must be inherited, must be re-membered” (2016: 27). Reflecting on my positionality and the ways in which I inherit TB histories and TB ongoing, I navigated an entry into anthropological research on TB. As the daughter of a paediatrician and medical scientist, I was exposed to a different side of TB, not the world of the patient, but the world of biomedical science[5]. My growing curiosity about the “behind the scenes” of science, specifically TB science, led me to a university-based scientific tuberculosis research division in South Africa that I call “the division.” The division was located outside of the city, near a public hospital. It was made up of various scientific research groups, each focusing on a different area of scientific TB research. I began conducting ethnographic research with scientists at the division towards the middle of 2016. The world of TB science allowed me to engage with some of South Africa’s cutting-edge scientific TB research, which showed promise of improving the burden of TB that has continued to overwhelm the country’s health system.

Inside the Biosafety Level 3 laboratory (BSL3 or more commonly, “P3”) – the special contained environment in which scientists worked with the contagious and pathogenic *Mtb* – it quickly became apparent that, more often than not, women outnumbered men. On the other hand, men outnumbered women in senior positions within the division. Over four decades ago, sociologist of science, Hilary Rose wrote, “For it is unequivocally clear that the elite of science – its managers and the constructors of its ideology – are men. Within science, as within all other aspects of production, women occupy subordinate positions, and the exceptional women who make it in this man’s world only prove the rule” (1983: 81). University of Cape Town (UCT) Vice-Chancellor, Mamokgethi Phakeng, has called this the “masculinity of power” (2015: 2). This has been supported in various degrees by contemporary South African and

[5] The “science” to which I refer in this thesis names the so-called “hard” or “natural” sciences, which espouse the kind of conceptual and methodological “matters of fact” (Latour, 2004). This understanding of science and its complexities (and uncertainties) are unpacked and elaborated throughout this thesis, particularly in Chapters 5 and 6.

African (often quantitative, barring a few exceptions) research and discussion on women's representation in science and academia (see Mama, 2003; Phakeng, 2015; Ngila et al., 2017), and the career challenges that women face because of their gendered roles and responsibilities (see Prozesky, 2008; Managa, 2013; Ngila et al., 2017; Prozesky & Beaudry, 2019; Prozesky & Mouton, 2019; van Staden et al., 2019) that are considered reasons for this gendered gap.

My research fell naturally into fieldwork with women because they were the scientists who dominated the BSL3 laboratory in which I conducted fieldwork. It was by default of the gendered structure of the laboratory, as well as my own identity as a woman, that women scientists became the focus. "Naturally" and "default" are important words, because they highlight an ethical and methodological dilemma that I had to interrogate. At the start of this research, I thought that a central theme would be how the patriarchal institutional culture of science – past and present – materialised in the everyday lives of my participants. I saw the laboratory as a space to think about societal gender politics, particularly the challenges that women face because they are women. But as I began writing this thesis, I realised, paraphrasing a phrase that Lesley Green had articulated in an Environmental Humanities seminar I took with her in 2017, that *what I saw blocked my sight*[6]. I elaborate on this shortly, as well as in more detail in Chapter 1.

OVERVIEW OF FIELDWORK, METHODS AND PARTICIPANTS

During my fieldwork, I conducted research with Leigh, Marina, Alison, Emily and Grace inside the division's BSL3 laboratories. On a few occasions, we worked in some of the division's other laboratories and, on one occasion, I went with Grace to an offsite cell imaging unit[7]. At the time of my fieldwork, Leigh, Marina and Alison were postdocs working on various projects that I will outline shortly. Emily was doing a PhD, and Grace was doing her Masters, but has since upgraded to a PhD. The ethnographic material has been drawn extensively from these five women scientists. Although this sample size is small, it in no way compromises the quality

[6] See Chapter 1.
[7] The names of the research participants as well as the scientific division are kept anonymous. All names are pseudonyms.

of the ethnographic insight. My ethnographic exploration was rooted in the cultivation of deep and meaningful relationships and the richness and depth that is gained from focused encounters. As will become clear in this thesis, focused and thick ethnography is valuable and can make significant contributions to knowledge production.

The research methods included observant-participation, “deep hanging out” (Geertz, 1998), extensive note-taking, in-depth conversations and semi-structured interviews. Observant-participation is adapted from anthropology’s signature methodology participant-observation, which was popularised by one of its founding fathers Bronislaw Malinowski (1922). Participant-observation strikes a balance between *participating* in the daily activities of research participants and *observing* what they are doing. I adapted participant-observation to observant-participation – or, participating through observation – because I did not conduct the actual scientific experiments and protocols, with the exception of staining some of Alison’s ZN slides.

Observation is an important methodology. As Tim Ingold argues, “to observe… is to attend to persons and things, to learn from them, and to follow in precept and practice” (2015: 157). As will become clear, there is a lot that can be learned from observing scientific practice. “Small facts” do indeed “speak to large issues,” as Clifford Geertz famously said (1973: 23). My observations were conducted alongside what Geertz has called “deep hanging out” (1998) whereby anthropologists gather their data from extensive and intensive periods of *hanging out* with their participants. From participant-observation and deep hanging out, anthropologists write what Geertz calls “thick description” (1973: 6), borrowing the term from Gilbert Ryle (1968). Thick description is a method by which “ethnographers compile highly detailed depictions of places and people in order to render fulsome interpretations of their perspectives and understandings of the world” (Hartigan, 2017: xvi). I continue the discussion of the methods in Chapter 1.

Fundamental to the development of the theory in this thesis was a presentation on my research that I gave in 2018 at a TB Clinical Forum, to which I invited the scientists from the division, as well the heads of the division. A debate that played out at the end of my presentation and in response to my research has been extremely valuable in developing my

theoretical argument. I discuss this further in Chapter 2. The arguments I make in this thesis were also informed by my experiences with many scientists in this division over the course of my fieldwork and the two public engagement projects that I was involved in with a large number of scientists in this division.

The first engagement project was an art exhibition of enlarged microscopic images of TB that I curated together with a handful of scientists from the division (see Image 3). The exhibition was shown in 2017 for the public and scientific community at a gallery in Cape Town, at a scientific symposium in 2018 and at a TB conference in 2018. The exhibition aimed to bring scientific TB research out of the laboratory and into the world, so that the public could engage with TB science and learn more about TB. During the exhibition opening in Cape Town, many scientists from the division were present to speak about their work, and members of TB advocacy group *TB Proof* shared their experiences of having TB and their struggles with TB drugs.

Image 3: **Gallery view of the art exhibition**, the public engagement project that I curated together with scientists from the division at a gallery in Cape Town. Photograph courtesy of Cliff Shain.

The second project was a school engagement initiative. After the art exhibition, we were approached by a member of a prominent TB research group to collaborate on an offshoot of the exhibition. The scientists and I, together with the research group and the provincial Department of Education, put together a mobile exhibition that travelled to three locations in a farming region heavily burdened with TB. The exhibition was visited by 900 school learners from 17 different schools. These learners were mostly from previously disadvantaged backgrounds and communities deeply affected by TB. I project-managed this mobile exhibition together with a postdoc from the division. Many scientists in the division volunteered to be involved and developed four exhibition booths. At these exhibition booths, scientists taught the school learners about TB – what it is, how it is transmitted, how to recognise signs and symptoms and the importance of treatment and treatment adherence. The scientists also worked to de-stigmatise the disease through games and activities, informed school learners about TB in animals and the importance of scientific research that addressed this, as well as spoke to the learners about scientific TB research. Through an experiment that they conducted with the learners at one of the exhibition booths, they hoped to get the students interested in and excited about science. My relationship with the division has been a very important entry way into the world of science. My experience with the many scientists during these engagement projects highlights my involvement with this division over an extended period of time, providing further depth and layering to the arguments that I propose in this thesis.

MORE THAN HUMAN RESEARCH

Heavily influenced by the nonhuman or "more than human" (Puig de la Bellacasa, 2017) turn in the humanities and social sciences, the second intention of this research was to align it with important shifts in these disciplines that opposed their human exceptionalism. Maria Puig de la Bellacasa uses the phrase "more than human" because "it speaks in one breath of nonhumans and other than humans such as things, objects, other animals, living beings, organisms, physical forces, spiritual entities, and humans" (2017:1). More than human became a significant phrase that I used throughout this research. It allowed me to encapsulate the vast array of humans and nonhumans that make up scientific TB research. TB science involved working with various cells, bacteria, species and technology. Inspired by the

nonhuman turn in the social sciences (Despret, 2004, 2016; Latour, 2005; Grusin, 2015; Haraway, 2016; Puig de la Bellacasa, 2017) and multispecies ethnography (Haraway, 2008; Helmreich, 2009; Hayward, 2010; Kirksey & Helmreich, 2010; Lowe, 2010; Tsing, 2012), this research was broadened to include the wide range of more than humans that populated TB science. My participants worked with *Mycobacterium tuberculosis*, *Mycobacterium bovis*, *Mycobacterium smegmatis*, human macrophages, mouse macrophages, mice, rhinos and lions[8].

MY PARTICIPANTS' SCIENTIFIC RESEARCH

At the time of fieldwork, the majority of which was carried out in 2018, my participants were involved with various research projects. Both Leigh and Marina were working with persisters. Leigh explained that persisters were considered a "hot" and "controversial" topic in TB science because not much was known about them. Marina explained that persisters form when TB bacteria are stressed, and they become stressed when they are exposed to TB drugs like isoniazid. A percentage of the *Mtb* population will shut down and go dormant in order to survive. These are the persisters. As Marina explained it to me, it is important to understand persisters, firstly, because they are a problem for relapse in patients. And, secondly, because they could be fatal for people who are high risk, such as people who are exposed to other diseases and infections when their immune systems are compromised. Marina's research at the time of my fieldwork focused on understanding persisters and their phenotypical differences to find ways to kill them. One of the projects that I observed her working on involved looking at sputum samples from a clinical trial before treatment started. She was retrospectively trying to see whether there could be an indication of the outcome of a patient. In other words, if the patient would be cured or if they would relapse. I also observed her working on an experiment that involved the growth and growth rates of *Mtb* inside the macrophage to compare normal bacteria to persisters.

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[8] Macrophages are immune cells that are responsible for killing potential microbial threats to the body. They are the body's first line of defence, it was explained to me. In TB science, macrophages are studied because they are responsible for attempting to kill the bacteria. Understanding how they do this and what prevents them from doing this successfully is, therefore, important. They were most often referred to as "cells" or simply, "macrophages." Grace explained that she "prefer[red] mouse macrophages because they are easier to work with. They grow faster and you want that. You want to get your results fast. They grow faster, they grow better. The human macrophages, they just take longer to grow, they are more sensitive."

Leigh's main research project was part of a treatment shortening arm of a clinical trial. She was analysing patient sputum samples after they had completed treatment to determine whether or not they had persisters. Put simply, the aim of the project was to determine whether or not patients could, in fact, shorten their treatment after four months (as opposed to the standard six-month TB treatment programme). The assumption was that even once patients had finished treatment and were said to be "cured" of TB, persisters remained. The patient might appear cured based on their x-rays and MGIT (Mycobacteria Growth Indicator Tube) results, but they might actually still have persisters[9]. Leigh needed to determine how many of the patients who had finished their treatment were likely to relapse. Towards the end of my fieldwork, Leigh was also heavily involved in the starting of the division's first animal laboratory where promising scientific research would be allowed to be conducted in mice.

Grace's research was about recreating the *Mtb* infection process to understand how the host responded to infection. Specifically, she was interested in the functions of the "parkin" protein, which was involved in autophagy. Autophagy is a pathway that degrades damaged organelles in the cell. It is also implicated in TB infection, where it is responsible for trying to clear the cell of the bacteria once it has been infected. Here, it is the immune response to the detection of a bacteria to clear the bacteria. *Mtb* tries to inhibit some of the proteins that are involved in autophagy, so that it can survive. Grace, therefore, infected macrophages with the bacteria and tracked the protein over time to understand the protein's role in this process when it was infected with *Mtb*.

Alison was involved in many research projects, but the one that I observed during my fieldwork with her involved culturing and testing lion tissue samples to see whether they were positive for *Mycobacterium bovis* – a relative of *Mycobacterium tuberculosis* that causes TB in animals. She did this for routine diagnostic purposes, to relay her results to the wildlife parks that wanted to find out the causes of death of their lions. Emily's work also had to do

[9] MGIT is a protocol used to detect mycobacterial growth and, very simply, is used to determine the presence of mycobacteria (or viable microorganisms) in a sample. If the instrument in which MGITs are placed detects life i.e., respiring microorganisms, scientists can culture MGITs to determine what microorganisms are present. In the context of this research, MGITs were used to detect *Mycobacterium tuberculosis* or *Mycobacterium bovis* (see Image 7).

with wild animals. She was part of the animal research group that investigated TB in animals. TB in animals is an overlooked and under-researched field in tuberculosis science because priority is given to humans, as Emily explained. TB is a "more than human" disease that implicates both animals and humans in complex ways. Emily's scientific research involved developing diagnostic tools for testing rhinos in wildlife parks. She had developed a diagnostic test, which was turned into a "kit." By following the protocol laid out by the kit, TB could be diagnosed in rhinos. Emily was also developing another diagnostic test for rhinos. It is important to be able to diagnose TB in rhinos for a few reasons. If rhinos have TB, the wildlife park is put under quarantine and the rhinos cannot be translocated. I was told by another scientist that rhinos that cannot be moved are targets for poaching.

BECOMING AVAILABLE TO CARE

As any anthropologist (or scientist for that matter) knows, a research project can be designed and planned with the greatest articulation and calculation, but good research can only happen when researchers remain open to what unfolds in front them. Alison described this beautifully in an interview when she said:

> I want to be floating because I feel like life is not about solid – this is the way it has to be, this is what I have to do. And I think a lot of scientists see that that is science, but that's not science. Science is about, science should be more like anthropology. It's not about okay I have a hypothesis, I must test it. Okay let's try something, someone has said this, *let's try it and let's observe what happens*.

I come back to Alison's words again and again throughout this thesis, for they come to stitch together many of its central arguments. "Observe everything," Neil Gaiman writes in his poem, *The Mushroom Hunters,* about scientists and the origin story of science (see Appendix B). Or, as biologist Thomas Henry Huxley said, "Sit down before fact as a little child ... follow humbly wherever and to whatever abysses nature leads, or you shall learn nothin" (in Hooykaas, 1987: 455). The openness and fluidity of good research is also what Vinciane Despret describes as "being available" (2004: 123). According to Despret, scientists who are available "give the opportunity to the 'subject' of the experiment to show what are the most

interesting questions to address to him [sic]; what are the questions that make him/her the most articulate" (2004: 124). Keep these concepts of openness and "availability" close, as they will take form as this thesis progresses.

The focus of this research emerged in the true spirit of unfolding and availability, on my first day of fieldwork for my honour's research project in 2016. I was sitting at a laminar flow cabinet inside the BSL3 with one of my participants at the time[10]. Speaking about the clumps of the highly-contagious and pathogenic bacteria on the petri dish in front of her, she said to me, "It may sound weird, but I love doing this. I need to take care of them. They are my babies" (Shain, 2017: 8). In one sentence, so much was revealed. In particular, the mother-baby metaphor that many of my participants would use to describe their relationship with not only *Mtb*, but various bacteria, cells and species as well as the caring and nurturing for the multiple species by scientists inside laboratories. This was the true starter culture of an exploration into the relationship between care and science that formed the foundation of this research. The focus on care has since pushed this research into all sorts of spaces both within and beyond the laboratory. In particular, emerging from the theme of care and the ethics of care that I observed inside the laboratory, came a theoretical focus on care.

I never had the intention to write about care. This concept was worlds apart from the research I thought I would be conducting when I first entered a scientific research laboratory. As I contemplated the world of science, I could never have imagined that inside the sterile environment of the scientific laboratory, I would observe care and nurturing for deadly bacteria by scientists. I did not know that this care would extend to the cells and species with which they worked. Nor did I think that scientists cared so deeply beyond the scope of their immediate experiment, namely, beyond the laboratory. It is important to note, from the outset of this thesis, that "care" was never my word. It was introduced to me in its use by the women scientists with whom I worked. "You develop a motherly instinct when you work with cells," Grace said to me one morning inside the small Tissue Culture Laboratory – home to

[10] The laminar flow cabinet, or more commonly referred to as the "hood," is a specialised enclosed scientific bench. The inside of the cabinet is separated from the outside by mechanised airflow that creates a curtain of air. This curtain of airflow ensures that the air inside the hood stays inside and the air outside the hood remains outside. This ensures *Mtb* or cells stay inside the hood and the hood remains sterile so that experiments are not contaminated by other bacteria or fungi that may be in the air outside the cabinet.

many cells that were growing in culture flasks placed inside warm incubators. She was speaking about her relationship with the cells that she grew for her research project:

> It's like caring for babies. Making sure they are happy on a daily basis. Cells, when they are stressed, you can see… you always check on them every day, make sure they are happy… if they are not happy and you carry out experiments on them, you won't get accurate results.

Relatedly, Puig de la Bellacasa explains that "Funnily enough, the term *accurate* derives from care: 'prepared with care, exact'; it is the past participle of *accurare* 'take care of'. Here, the notion of doing something with care led to that of 'being exact'" (2012: 211). Since obtaining accurate results is a fundamental part of science, care is indispensable to scientific research. The caring that happened in scientific research formed the basis of the relations between humans and more than humans inside the laboratory. Caring for the subjects of scientific research translated into carefully conducted experiments that would result in good scientific results. In this way, care is vital to science.

The theory that I develop around care was first and foremost informed by observing and listening to the descriptions of the relationship between my participants and the bacteria, cells and species that populated their research projects. As could be gathered from Grace's account, the concept of care and its associations are deeply gendered. Women are associated with roles of care, particularly in the caring for babies and children (see Ruddick, 1980). I discuss this in Chapter 2. This research explores and interrogates the theme of care, with its particular connection to women scientists. This research *does not* make the argument that only women scientists care. Rather, it focuses on the importance of care in science and what an ethic and philosophy of care could mean for science in spite of care being considered "feminine." Within the caring that I observed inside the laboratory and beyond it, I noticed a significant scientific practice. My participants' careful and caring ways of being and conducting science could make important contributions to the discussion of decolonising science. This juxtaposition does not challenge the scientific grounds of science such as the value of the scientific method, but rather provides a potential avenue to create a more caring science and institutions of science that are sensitive and available to scientists, humanity and

the environment. By now, it should be clear that there were many layers that made up this research and the direction it took. Although they might appear disparate, they will come together with some weaving.

WEAVING: STYLE, STRUCTURE, THINKING

Speaking about Navajo weaving, Haraway writes, "Weaving is a useful practice, to be sure… but fundamentally, weaving is also a cosmological performance, knotting proper relationality and connectedness into the warp and weft of the fabric" (2016: 91). Haraway also describes Navajo string games as "continuous weaving" to tell stories (2016: 14). This thesis follows a similar weaving practice. The threads of my observations and my participants' experiences and descriptions obtained through the ethnographic research that I conducted are woven through my engagement with theory. Informing – and further weaving – this thesis is the multispecies thinking that is heavily influenced by Haraway (2008, 2016) and Puig de la Bellacasa (2017), the field of science studies or Science and Technology Studies (STS) with scholars such as Bruno Latour (2004) and Isabelle Stengers (2018), and care theory, which has been profoundly shaped by scholars such as Carol Gilligan (1982, 1987, 2011), Nel Noddings (1984) and Joan Tronto (1993). These are the overarching theoretical knots as well as the relations and connections that are required to perform the kind of mental gymnastics that is essential to understand how the fabric of this thesis comes together.

I am inspired by the ground mats sewn from *salaula* scraps by Zambian tailors (see Hansen, 2000). *Salaula* is a Bemba word which translates as "to select from a pile in the manner of rummaging" or "to pick" (Hansen, 2000: 1). It is used in the context of the second-hand clothes that come from both Europe and the United States to African countries like Zambia where they are sold at markets. The mats are a bricolage of the global North's discarded clothing, fashioned into something new. Like these mats, the thesis itself is a tapestry of a myriad of fabrics from multiple sources that are woven together. What this means is that the structure and style of this thesis follows a different kind of unfolding (or folding). The tapestry might at first seem disjointed. However, please bear with me. Weaving has to begin somewhere. At the beginning of the process, it is always hard to imagine the final piece. The beauty of *salaula* mats come from the vibrancy of their disparate parts. Since I am inspired

by *salaula* mats, the final product will indeed be an assemblage of many parts. In order to fully grasp how the parts interlace, interweave and join, I require the reader to be actively involved in the "continuous weaving." This is an exercise in creative co-creating, in inviting meaning-making *together*.

Relationships and cultivating relations and connections are therefore central to the fabric of this thesis. This *salaula* tapestry is fashioned using key concepts that together make up the whole. *Whole* is an important word here. It shifts away from a hierarchical way of thinking and moves into holons and holarchies as a way of thinking and a mode of being in the world[11]. As the focus on multispecies caring relationalities leads to questioning a colonial model of understanding the world and suggests a turn towards other ways of being and relating, I am intrigued by the difference between hierarchical and holarchical models of understanding the world. The hierarchical model of the world situates humans above nature. The world here is a mechanism rather than an organism. This view came with the enlightenment (modernity) where the earth was thought of as a complex machine that could be understood by science (Hooykaas, 1987: 455). Science was used to exploit the earth for human benefit. The relationship between human beings and the earth became extractive, and nature as well as relationships became financialised (Green, 2020). With modernity came the nature/culture split. There are huge political and economic interests in maintaining this world view. "Modern science favours a mechanistic world picture, explaining natural phenomena as much as possible by analogy with a mechanism. Ancient science, on the other hand, tended to an 'organistic' world view, regarding non-living things as to a large extent similar to organic beings," writes historian of science Reijer Hooykaas (1987: 455). While the former is a hierarchical model of the world, the latter is holarchical.

In a holarchical model, humans are understood as part of a greater whole. Rather than independent, human beings are interdependent and inter-related to each other and

[11] The term "holon" was conceptualised by Arthur Koestler (1967). The concept has been popularised in manufacturing (see, for example, Babiceanu & Chen, 2006) and contemporary design, particularly sustainable design (see DeKay, 2011). I am indebted to South African environmental lawyer Cormac Cullinan and his discussion of holons and holarchies in an unpublished presentation he gave at the University of Cape Town in 2017 for a seminar in the Environmental Humanities course *Science, Nature, Democracy.* Understanding the world as a holarchy (interconnected) rather than a hierarchy (with humans above nature) was fundamental to the philosophy he used for the protection of the planet.

everything else on the earth. Because of this, it is important to note, following Tim Ingold, that "We should… resist the temptation to equate holism with finality or completion. The meeting of minds weaves a whole rope, *but so long as life goes on, there must always be loose ends*" (2015: 12, emphasis added). *Whole* does not suggest completeness, it implies relationality and the reality of connection. Wholes are always parts and parts of other parts and wholes. Boundaries are porous, ends are loose, and everything is in perpetual relationship to everything else. This way of thinking and being in the world aligns with Haraway's (2008, 2016) relational ontology, which is central to this research.

Haraway's relational ontology is based on the notion that "critters do not precede their relatings" (2016: 60). Life is possible because of relations. In *Staying with the Trouble*, Haraway (2016) draws on evolutionary biologist Lynn Margulis' theory of the "holobiont" (1991), and Environmental Studies Master student M. Beth Dempster's conceptual framework of "sympoietic systems" (1998), to develop what she calls "sympoiesis." Interdependence is at the root of each of these concepts. "Nothing makes itself; nothing is really autopoietic or self-organizing," Haraway explains (2016: 58). Margulis' "holobiont" (1991) is precisely this acknowledgement that biological entities are comprised of various companions. Humans, for example, are made up of multiple organisms including bacteria and viruses. Individualism and boundedness become impossible to think with. Sympoietic systems are "collectively producing" and they "do not have self-defined spatial or temporal boundaries" (Dempster, 1998: v). These are not abstract theories, as Haraway reminds us, "neither biology nor philosophy any longer supports the notion of independent organisms in environments" (2016: 33). Reality is defined by inter-relatedness and inter-connection.

This understanding of sympoiesis is central to the nonhuman turn in the humanities and social sciences. It is about relation rather than alienation, relationships and connection rather than detachment, us rather than I. Sympoiesis is a deep understanding of the reality that human lives are entangled with other humans, more than humans, and the planet. Ingold (2015) has also written about this understanding, conceptualising it in terms of lines and knots. In his model, living beings are lines – bundles of lines, to be exact – and life is a "meshwork" of those lines (Ingold, 2015: 3). "Nothing can hold on unless it puts out a line, and unless that line can tangle with others," Ingold (2015: 3) writes. This is an acknowledgement of

sympoiesis, of the connections and entanglements between things (living or not) that make life possible. This philosophical and theoretical approach helps to unpack the kind of relationship-making that I observed in the laboratory space, and has resonance even beyond, as we all engage daily in "a dance of relating" (Haraway, 2008: 25) with many kin and kinds. Interestingly, *Mtb* is in a constant "dance of relating" or sympoiesis with humans. The issue with *Mtb* is precisely its entanglement with human lives and the consequences thereof.

The shift of the structure of the thesis is therefore from a hierarchy – in which organisation follows rank – to a holarchy – in which organisation follows a sympoietic nested system where parts work together to form wholes. This reinforces the central concepts of this thesis: relationships, flow and movement, care, weaving and relation-making. These concepts, which I observed through ethnographic fieldwork and put into relationship with bodies of theory, inform the argument of the thesis. The structure of the thesis, therefore, is in alignment with its central concepts. In particular, its overarching framework as both a multispecies and decolonial project.

WEAVING AS A MULTISPECIES AND DECOLONIAL APPROACH

Travelling through the Kalahari Desert in the Northern Cape of South Africa at the end of 2020, I was intrigued by the peculiar structures that I saw on the electrical and telephone poles that ran parallel to the road (see Image 4). Small birds fluttered about the thatch-like constructions. Sending a WhatsApp message to a birder, I asked what these structures were. "Sociable weaver nests," I was told, followed by, "very descriptive name!" Not only were the birds *weavers*, drawing striking parallels between my own structural and theoretical weaving, but their "sociable" nests were perfect examples of holons in both form and function. Each nest can consist of up to 100 nesting "chambers" entered through various entrance tunnels[12]. Each chamber is home to a family of birds. Nests can support around 400 birds. These are community nests where weavers work *together* to look after and feed their young and maintain the entire nesting structure for themselves and for future generations. Moreover,

[12] Information on sociable weavers was obtained from Delia du Toit (2019), Christian Boix (2013), Bernd Heinrich (2014), the FitzPatrick Institute of African Ornithology at the University of Cape Town website (2021) and the San Diego Zoo Wildlife Alliance website (2021).

these nests are multispecies homes. Other birds such as falcons, barbets, lovebirds, finches, sparrows, vultures, owls and eagles nest and roost with sociable weavers. Kalahari Tree Skinks also use the nests and scarab beetles use the bird droppings underneath the nests. Professor Graham Alexander, a herpetologist at the University of the Witwatersrand in South Africa who became interested in sociable weavers because of their relationship to the reptiles he was studying, explains that "Sociable weavers are called ecological engineers because, by making homes for themselves, they influence the ecosystem and benefit other animals" (in du Toit, 2019: n.p.). If ever there was a good example of Haraway's "companion species" (2003), it is the sociable weaver. Their weaving is of many kinds. Their nests are sites of multispecies entanglements, community and flourishing. They are the poster children for sympoiesis, and humans have a lot to learn from them.

Image 4: Sociable weaver (*Philetairus socius*) nests. Nests seen beside the road in the Kalahari Desert, South Africa. Sociable weavers use telephone and electrical wire poles on which to build their nests. Photograph by me.

Important here is the idea that we are not alone, nobody and nothing is an island. "TB needs friends," I was told many years ago when I asked why the bacteria clump (see Images 1 and

2). I was also told that macrophages like "company" and mice get "lonely." Since care frames this research, I take on Puig de la Bellacasa's (2012, 2017) "thinking with care," which is inspired by Haraway's (2008, 2016) relational ontology so that "thinking with" becomes thinking with the many that make up the one, or, in fact, that we are never just one, but always multiple (Puig de la Bellacasa, 2017:71). Thinking with care is, therefore, about thinking in the collective. This has a significance for the writing style because, as Puig de la Bellacasa explains, academic writing with care is "writing-with," which shows the collective that "*populates* a world" (2017: 77, original emphasis). This way of thinking and writing is not necessarily appreciated in academic institutions:

> Academic institutions do not really value eclectic writing-with, especially when it explodes the category of disciplined "peers" by including unruly affections… What I find compelling in fostering a style of writing-with as a pattern of thinking with care is not so much who or what it aims to include and represent in a text but what it generates: how it actually creates a collective and *populates* a world. Instead of reinforcing the self of a lone thinker's figure, the voice in such a text seems to keep saying: *I am not alone*… But probably the perception most challenged by relationships of knowledge that encourage relations of care might be that affective attachments to collectives are seen as misplaced in academic texts, deemed empathetically uncritical, or even self-indulgent (Puig de la Bellacasa, 2017: 76-7, original emphasis).

What Puig de la Bellacasa highlights above is important. The notion of *generating* through connecting ties together with the argument for *growing* a decolonised science, which I put forward in Chapter 6. The writing style of this thesis follows connected thinking and writing-with. My emphasis on weaving and creating a *salaula* tapestry or a sociable weaver nest, generates a product that is an assemblage of thinking with many, writing with many and *doing* with many. I adopt weaving in all of its iterations. Weaving theory and practice, weaving thoughts, weaving experiences, weaving stories, weaving multispecies relations, weaving care, weaving humans and more than humans, and weaving science and society. The last iteration is central to the argument I make in the final chapter for a decolonised science.

Weaving is a practice of connecting that has relevance for decolonisation since, as Green (2020) argues, colonisation involved separating things from their relationships with other things[13]. This included the separation of people, the separation of people from land and the separation between human beings and nature – the last one being the ultimate colonial "civilising mission." Weaving as connecting to form wholes attempts to counteract the ways in which colonisation "cut up," as Mavhunga (2017a: xi) writes:

> The project of addressing the meanings of science, technology, and innovation from Africa had to be philosophically grounded, because to my understanding the colonial ordering of knowledge had cut up African knowledge, knowledge production, and structures and modes of knowing into tiny pieces. What had once been a whole entity known as a composite was now scattered into specialist disciplines (2017a: xi).

As Mavhunga argues above, African knowledge was fractured during colonisation[14]. Attempts to bring various knowledges and beliefs together to create wholes is therefore an important decolonial practice. Haraway writes, "Like all offspring of colonizing and imperial histories, I – we – have to relearn how to conjugate worlds with partial connections" (2016: 13). This connected thinking and writing – conjugating – forms part of my academic efforts to decolonise our ways of thinking and doing. Conjugate also has significance for this project since its definition in biology includes how organisms such as bacteria come together to exchange or transfer genetic material or merge to create a single organism. Connection is very important, as many of the following chapters argue. Weaving speaks to this connection and conjugation.

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[13] This kind of reductionism is part of what Aimé Césaire describes in his equation "colonization = 'thingification.'" (1950: 42).

[14] "Africa" and "African" are used to refer to the African continent and its people. Throughout this thesis, they are used with full recognition that Africa is not a single homogenous continent, but a continent of diverse nations, people, cultures and knowledges. For the purpose of this thesis, "Africa" and "Africans" are used not to stereotype, but rather to provide a means of comparison to analyse the terms of engagement and relationship between the continent of Africa and Euro-America or the global North. More specifically, these terms provide a framework in which the decolonial argument with regard to institutional knowledge and institutional knowledge production can be discussed. "Africa" and "Africans" are used by both students (see Schulz, 2016) and academics (see Nyamnjoh, 2012, 2017; Mbembe, 2015; Mamdani, 2019) in order to frame decolonisation within the university. Therefore, the analysis in this thesis acknowledges that "Africa" is a complex entity with multiple and conflicting power dynamics. The use of these terms in no way ignores these complexities. Emily and Grace's experiences as foreign African students, which is detailed in Chapter 5, cuts through any conceptualisation of Africa as a single, homogenous entity and points towards some of the distinct power dynamics between African countries, specifically between South Africa and the rest of the continent.

This thesis, therefore, follows a unique structure. Rather than clearly defined chapter introductions and conclusions, it is important that the chapters and their multiple sections weave into one another. This ensures they are not read as bounded and individual segments, but part of the whole. Therefore, flow and movement between chapters and sections is prioritised. Each chapter opens into the next. Like the holobiont or sympoiesis, the chapters do not exist alone, and so they are written in ways that do not close, but open. Again, it is very important that the structure aligns with the central tropes of this thesis. The structure follows the content, concepts, observations and arguments. The structure also takes inspiration from Susan Levine's use of flash ethnography in her book *Children of a Bitter Harvest: Child Labour in the Cape Winelands* (2013). She adapted the genre of flash fiction to produce a book made up of short "snapshots" that work together to piece the complex whole (Levine, 2013). This also reminds of Marilyn Strathern's (2005) concept of "fractals" or "partial connections" that can never on their own claim wholeness (see Abrams, 2018: 27). Following each of these ideas, this thesis is woven together from its many parts.

Integrating weaving is also a decolonial move within a research project on science because as Michel Serres writes, "I understand the weaver to be a pre-mathematical technician more ancient than the surveyor" (in Green, 2020: 87). I think of the work of Paulus Gerdes including *Lunda Geometry: Mirror Curves, Designs, Knots, Polyominoes, Patterns, Symmetries* (Gerdes, 2008) and *Otthava: Making Baskets and Doing Geometry in the Makhuwa Culture in the Northeast of Mozambique* (2010). Gerdes' (2008, 2010) work inserts African weaving into the archives of science and technology, displacing the Eurocentric and racist history of science that situates scientific innovation and discovery solely within the global North. This is discussed briefly in Chapter 6. For now, it is important to note that weaving as theory and method was a useful tool in aligning the structure with the argument in this thesis. My comparison to *salaula* mats, however, might seem to counter the decolonial framework of this thesis.

Salaula mats are, after all, comprised of materials discarded by the global North that make their way to African countries. However, this unidirectional flow from North to South provides commentary on the pervasiveness of Western knowledge traditions, or how "The intellectual

journey always starts in Europe" (Naudé, 2019: 219)[15]. Raewyn Connell calls this "The Northernness of general theory" (2007: 44). Part of the decolonisation of knowledge in the university involves interrogating this tendency (see Nyamnjoh, 2012, 2017; Mbembe, 2015; Naudé, 2019). My use of the *salaula* mat as a metaphor for the structure of this thesis acknowledges the complexity of one-way flows in the production of knowledge. Because of this one-way flow, Nyamnjoh argues that African education seeks "mimicry over creativity" (2012: 129). But it must be pointed out that academics from the global South are not mere passive recipients of theory from the global North. Karen Hansen writes, "For salaula the work of production does not end in consumption; it begins there" (2000: 247). I want to use this statement to highlight the creative ways in which "Northern" theory is engaged with and turned into something else, like the second-hand clothes that are assembled into *salaula* mats. This thesis does exactly this. After all, boundaries are porous, and the origins of things are not always what they seem. Jean and John Comaroff write, "there is much South in the North, much North in the South, and more of both to come in the future" (2012a: 127). *Salaula* items may very likely have been manufactured on Asian soils long before they made their way onto Euro-American bodies. This begins a larger discussion on race.

WEAVING RACE

Mamokgethi Phakeng writes that "Feminism among Africans has also not fared well, because of its epistemological whiteness… Feminism therefore often sets up a rivalry between black and white women, because it has generally been soft on racial and class inequality" (2015:1)[16]. It is very clear that women of colour are significantly more disadvantaged than white woman. Deeply aware of the critique of feminist theory that it "has not reflected well

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[15] In a reversal of this – as well as an intervention to this tendency – Jean and John Comaroff (2012b) provide an argument that disrupts these one-way flows of knowledge and overcomes the North/South binary. Placing the global South at the centre, they highlight the value of thinking from the global South to understand global problems as well as the importance of robust theory to be exported from the South to the North as Euro-America begins to resemble (or "evolve towards") Africa.

[16] As discussed in footnote 2 of this chapter, under apartheid legislature, the South African population was classified into racial groups "white," and non-white ("African/Black," "Coloured" and "Asian"). These classifications – most often "white," "black," "coloured," and "Indian" – are commonly used today by South Africans to identify themselves and others. Ignoring racial classifications, a so called "colour-blind" approach, ignores the significant ways in which race dynamics continue to affect contemporary South Africa in a myriad of ways. The student protests of 2015 and 2016 and the scholarship that emerged from student activists such as Rekgotsofetse Chikane (2018) during this period highlighted the impossibility of thinking beyond race in contemporary South Africa. I discuss this in Chapter 6.

the experiences of women of colour and of other marginalized women" (Tronto, 1993: 12), I paid attention to the intersections of gender and race with regard to science when it came up in my research. It was not, however, my main focus. The topic of women of colour in Science, Technology, Engineering and Mathematics (STEM) deserves its own research project. I want to make it clear that this research does not do justice to the politics of race and the intersections of race and gender, but I do not ignore them. Emily, Grace and Alison were all women of colour. Racial politics were undoubtedly part of their lived experience and experience within the institution of science. Grace and Emily were African nationals from Nigeria and Zambia, respectively. They in particular faced struggles because of their nationality, which I discuss at length in Chapter 5.

There is also a deep connection between care and race. Tronto reminds us of the links between race, class and gender, where caring for children, the sick and the elderly are historically and presently "disproportionately carried out by the lowest ranks of society: by women, the working class, and in most of the West, by people of colour (1993: 113). This is the history etched onto care. South Africa is no different. It is women of colour who fulfil the majority of the labours of care in South Africa[17]. They are the domestic workers, cleaners, child-carers, carers for the elderly and nurses. Most often, their caring is for South Africa's white minority. Their caring enables the continuation of the political economy and the status quo. Their caring labours around the household enable their families and employers to work outside the home, as I discuss in Chapter 2. Often the socio-economic position of these women as a result of South Africa's colonial legacy and apartheid history meant that their school education – under the Bantu Education Act of 1953 – was strategically limited to learning domestic (care) tasks such as cleaning and sewing. This severely curtailed their career options. Even though this has changed since the formal end of apartheid in 1994, many women of colour in South Africa still find themselves in this predicament, with an inadequate

[17] For an overview of care work in South Africa, see Francie Lund (2010) and Lund and Debbie Budlender (2009). For more recent scholarship on domestic work in South Africa see Shireen Ally (2009), Tanja Bosch and Caitlin McLeod (2015) and Bridget de Villiers and Michelle Taylor (2019). For earlier, but no less relevant scholarship on domestic workers in South Africa see Jacklyn Cock (1980) and Deborah Gaitskell et al. (1983). Of further significance in relation to the ways in which care-work in South Africa is gendered, raced and classed, see Olagoke Akintola (2006). For the impact of South Africa's COVID-19 lockdown on care work and the different ways it affected men and women's (care) labour see Daniela Casale and Dorrit Posel (2021).

education and a limited skill set. Structural violence continues. Care-work, gender and race are tightly knotted.

In the world of science, as anywhere, the politics of race are indeed at play, woven into the very fabric of structures, institutions and human psyches. In South Africa, these issues were put under the microscope with the call to decolonise science that came from the #RhodesMustFall (#RMF) student movement in 2016. This student movement and its relationship to science is explored in detail in Chapter 6. This is the way in which this research engages racial politics in South African science. Since the question of decolonising science is a broad and complex topic, the framework that I offer in this thesis is based on connecting the laboratory and the world beyond it to grow a more relevant and caring science.

WEAVING A FRAMEWORK FOR DECOLONISING SCIENCE

While the push from #RMF to decolonise the university as an institution was at the forefront of the student movement, the call to decolonise science in particular was made explicit with a video that went viral on YouTube in 2016 (see UCT Scientist, 2016). This video documents a few minutes of a panel discussion at the University of Cape Town's science faculty in which Miki Moyo, a member of the #RhodesMustFall student movement, provides an account of what it means to decolonise science (UCT Scientist, 2016). The call for the decolonisation of science by the #RMF students has come from many things, including but in no way limited to the role of science in perpetuating racist and white supremacist thinking as well as the positioning of science as a superior form of knowledge within the African university. In the context of this research project, however, one of the critiques by the students that I am most interested in is the ways in which science is felt to be disconnected from the world in which it exists, particularly the African world. In her discussion, Moyo said that decolonising science is "having knowledge that is produced by us, that speaks to us, and that is able to accommodate knowledge from our perspective" (UCT Scientist, 2016). Moyo spoke to the disconnections, the cuts, between science and "an African perspective" (ibid). This sentiment was echoed in many of the responses by students in this meeting who framed their argument around the need for science to respond to "African problems" (see Schulz, 2016).

During the two-hour Science Faculty Engagement meeting from which the short clip was taken, many of the students' contributions to the topic of decolonising science were centred around relevance (see Schulz, 2016). Following this argument, the topic of decolonising science in this thesis is framed around this aspect. Relevance is a complex argument, which brings to the fore questions such as: What are "African problems"? Who are "Africans"? Who decides what science responds to? Who decides what is relevant for Africa? While "Africa" and "Africans" are not unified and homogenous categories, this framing helped the students articulate the kind of thinking that is necessary to interrogate science in South Africa. One of the students in the Science Faculty Engagement meeting said, "I don't think anyone is coming here with answers. We all don't have answers… But it's a commitment to finding out" (see Schulz, 2016). This meeting was an exploration into what it might mean to decolonise science, however complex. The category of Africa and Africans helped to situate the discussion on relevance as relevance to them.

For the students in that meeting, a decolonised science is one that is in touch with and connected to the (African) world in which it exists. Indeed, science has had many connections and relationships beyond the laboratory – with military, with pharmaceuticals and with commercial industries. But relationships with African worlds, that provide meaningful and directly impactful benefits to those worlds is what the students felt was missing. As such, I use what the students argued in that meeting as the foundation for my discussion on decolonising science as a way to centre their voices and remain available to their visions of becoming. Each chapter of this thesis builds on the other chapters to weave an argument on decolonising science in relation to care. The ethnography details how my participants were germinating the seeds and growing the kind of science that was imagined by the students in the Science Faculty Engagement meeting.

THESIS OUTLINE

Chapter 1 "Weaving Methodology and Ethics: An Argument for Slowness and Patience" outlines the methodologies and ethics of this research. The methods and ethics were drawn from and spoke directly to my observations and experiences in the field. This chapter interrogates my own "matters of concern" (Latour, 2004) and highlights the importance of

acknowledging that anthropological research is thoroughly subjective. Temporality becomes a major theme as I develop a methodology called in-between-methodology. In-between-methodology speaks to the fuzzy and porous boundaries between what does and does not count as research and when research is and is not happening. The in-between calls attention to care as well as the forgotten and neglected labour that happens in the time-spaces between. The slow temporalities of *Mtb* meant that scientific research with this pathogen was slow research, at odds with what I call "scientific time" – the fast pace of science fuelled by its dogma of "publish or perish." This chapter explores the accelerated pace of science and the temporal tensions that emerge because of it, including the tensions between "care time" (Puig de la Bellacasa, 2017: 171) and scientific time as well as the temporal tensions between the rhythms of women's and men's scientific careers in the face of having and caring for babies and children.

Adjusting to the temporalities of the bacteria and the slowing down required to either have balanced lives or families, my participants disrupted dominant scientific timescapes. This begins the argument that what my participants cared about was at odds with what science cares about, a thread that is woven throughout the following chapters. In this way, my participants urged for a different kind of scientific timescape that saw value in patience, slowing down and being responsive to the needs of women scientists. I draw on Isabelle Stengers (2018) argument for slow science as a tool to rethink science in order to make it respond in ways that are *relevant, impactful and caring*. This is about questioning what "counts" in science, or what science cares about, so that a science that connects the laboratory to society, that serves humanity rather than industry, that is relevant to the world in which it exists, is able to emerge.

Chapter 2 "Thinking with Care: Care and Science in More than Human Worlds" engages with the theme of care, showing how my participants' caring for cells, bacteria and other more than humans intersect with how care has been defined and written about in the literature. Putting my fieldwork into conversation with care literature, I argue that care is grounded in relationality. The understanding of togetherness, relationality and interconnectedness is a cornerstone of care. Connection is a central thread that runs throughout this thesis and becomes more important as the thesis unfolds. Importantly, this chapter explores care's

contradictions, pushing care beyond a "feel good" emotion. From caring to killing, harvesting and exploiting, this chapter engages with the messiness of care through thick description. This, however, does not make relationships between researcher and researched any less caring. I argue that scientific practices are carefully thought out and interrogated. Scientists were not robotically carrying out scientific protocols. They were thinking, reflecting, conversing, interrogating and caring.

Situating care within the scholarship on moral theory from Gilligan (1982, 2011), I also explore the gendering of care and the ethics of care – though I argue that *care is in no way limited to women or women scientists.* Interestingly, while the pillars of science mirror the ethics of justice (a moral theory that is in direct contrast to the ethics of care), the science that I observed was rooted in the ethics of care. I engage with Puig de la Bellacasa's "matters of care" (2017) to show the "different voice" (Gilligan, 1982) of science. This reflects the narratives of care and affect that make their way into the experiment and beyond it, highlighting that subjective experience can never be separated from fact, that matter has meaning, that the natural and the social are not mutually exclusive, and that science is produced by people who feel and care. The voice of care is a different voice because it inserts the lifeworld of the scientist into the purified science, disrupting the "matter of factness" of science. This begins my argument about care's disruptive potential. Since interdependence, connectedness and relationships are central to care, a caring science is a science that is connected to the world in which it exists so that it is driven by what society needs and cares about. This brings to the fore whether scientists actually care and highlights the very real disconnect between science and society – an argument raised by one of my participants. I use her argument to frame the importance of care in science beyond the laboratory and a more caring science – being one that *connects* the laboratory and community – as a way to decolonise science.

Chapter 3 "Science and the Body, and the Body of Science" explores the relationship between sensing and knowing in scientific research through an analysis of the five senses of the scientist. I turn to the theory of embodied knowledge, or what Michael Polanyi calls "tacit knowledge" (1966) and Ingold calls "skill" (2018) to situate an "objective" discipline in the "subjective" space of the body. A science devoid of people ("outside" of society) becomes

impossible to think with. People are intimately involved in the production of scientific results. Latour's "matters of concern" (2004), which encapsulate this understanding, urges us to slow down, hesitate and ask what the concerns of the scientific research are. Are there other concerns that matter? This is important for decolonising science because central to these questions is the interrogation of what science cares about. Relevance or excellence? Problems that concern industry or problems that are relevant to humanity? Importantly, while this chapter expands on the arguments of STS theory, it does so with the acknowledgement that in this research project, the ethnography came first. My participants had raised many of these arguments during my fieldwork, showing that scientists cannot be lumped together as they are in accounts of science by scholars such as Stengers (2018) and Green (2020).

Chapter 4 "Porous Boundaries: Touching, Being Touched and Being in Touch" centres conceptions of fluidity, flow and the porosity of boundaries. I explore the entanglements between my participants and their cells and samples to make an argument about how touch breaks the boundaries between mind/body, subject/object, human/nonhuman, researcher/researched, subjectivity/objectivity and the laboratory/"outside world" or science/society[18]. Through ethnography, I look at how touch facilitates relations. Touch becomes a way to think with the fluidity of boundaries and confuse the idea of boundedness. The focus on touch furthers the discussion of subjectivity or "the personal" (Polanyi, 1958) in scientific research that emerges through each of the chapters. Scientific knowledge comes from deep immersion and the intimacy of knowing. In this way, the "reversibility" of touch (Puig de la Bellacasa, 2009: 300) – that to touch is to be touched – comes to the fore.

My participants were deeply touched by what they did. Being touched dissolved the boundaries that separated them from what they researched (whether cells, bacteria, samples, rhinos or humans) as well as from the world beyond the laboratory. I, therefore, argue that touch and the closeness it requires brings caring to the foreground. Once one has been in touch, it is hard not to care. I show the complexity between the kind of detached

[18] "Outside world" refers to the world beyond the laboratory. Sarah Franklin refers to this as the "external world" (2013: 70). I also use "world beyond" and "real world" for the same purpose. It is a way that I conceptualise the real and imagined boundary between the inside and the outside of the laboratory in order to speak about the relationship between scientific research and the community, world or society in which it goes out into as well as the relationship (or lack thereof) between science and society in general.

touch that science calls for that does not allow for the thick entanglement that touch can lead to. I argue that in the face of protocols that distance the scientist from their science, my participants created space for caring that connected across the researcher/researched, lab/world and science/society boundaries. These stories make detachment in science hard to think with. This *does not* refer to experimental bias or interference with the high standards of the experimental system. It was this connection and entanglement, as one of my participants said, that makes for better and more careful and caring scientists. With touch comes the kind of entanglement that orients a scientist into the world of the researched. From this comes deep understanding that scientific research needs to be relevant, bridging the translational gap in the sciences. My participants' touch and the care that emerged because of it, wove the laboratory to the world. This is what a decolonised science does, as Chapter 6 "Must Science Fall?" argues.

Chapter 5 "What do Scientists Care About? What Matters?" goes even further to collapse the boundaries between the laboratory and the world outside of it through showing the very real ways in which my participants wove connections between the two. Their care extended far beyond the laboratory. Each of my participants put their heart into their research, developing a personal and emotional connection to what they studied. This meant that they wanted to take their time to do things the right way, a pace that was counterintuitive to the fast-paced, highly productive, publish-centric world of science. It also meant that they refused to be defined by what science counts as success. They cared about teaching and sharing their knowledge, about creating relationships with the community and the public through various engagement projects, about capacity development, skills transfer, being of service, mentoring and so much more. They cared about each other and understood the importance of collaboration, puncturing the predominantly selfish and egotistical culture of science. Respect for others mattered more than self-preservation and careerism through competition. People mattered. Some of my participants developed projects that had an impact in creating an inclusive scientific culture – this involved commitment to deep change at the institutional level. In these ways and many more, this chapter describes how my participants challenged Stengers' (2018) argument that scientists are "sleepwalkers" who need to be woken up. I argue that my participants embodied a decolonised science and that what they cared about

and how they acted upon those cares could serve as important guides in decolonising the university and institutions of science.

Chapter 6 “Must Science Fall? An Argument for Growing a Decolonial Science” outlines the protests by South African students in 2015 that captured global attention. The student-led movement that became known as #RhodesMustFall (#RMF) called not only for the removal of the Cecil John Rhodes statue at the University of Cape Town’s (UCT) upper campus, but the removal of the colonial institutional culture and university curriculum. In 2016, a group of #RMF students called for the decolonisation of science. This chapter sketches the socio-political moment in which this research was conducted and whose impacts are still felt within the institution. Centring a meeting that occurred at UCT’s science faculty on decolonising science (see Schulz, 2016), this chapter explores the argument for *relevant* science that was put forward by the students. The students in this meeting were grappling with the multiple separations and disconnections in science – such as that between nature/culture, science/spirituality, truth/belief and university/home – that led them to feel that there is no place for them and their lifeworlds within the discipline of science. The students called for a science that does not alienate them or ask them to leave their culture at the door. Students argued for a science that connects the laboratory and the (African) world outside, overcoming various real and imagined boundaries. This is about inserting what Africans care about into what science cares about. Specifically, a request for a science that responds to the community in which it exists.

In this argument, relevance needs to be at the foundation of scientific exploration and innovation. That is a decolonised science. Based on the ethnography in the chapters leading up to this one, I argue that a decolonised science is a caring science because it connects the laboratory and the world outside of it so that it responds in ways that are relevant, impactful and meaningful. The students were calling for individuals and institutions that are aware of what society cares about, of the porous boundaries between the lab and the world outside, and of the need for connection between institutions of knowledge and the communities and contexts in which they exist. This is fundamental to growing a caring and decolonised science. By exploring the student call to decolonise science through this meeting, this chapter shows how my research, and the observations and arguments that emerged from it, speak directly

to the kind of decolonised science that the students imagined. My participants were indeed growing a more caring science and institutions of science, germinating the kind of seeds that it would take to grow a decolonised science.

CHAPTER 1 – WEAVING METHODOLOGY AND ETHICS: AN ARGUMENT FOR SLOWNESS AND PATIENCE

"WHAT YOU SEE BLOCKS YOUR SIGHT": MY MATTERS OF CONCERN

In an interview with one of my participants, I raised something that she had said to me in the laboratory about some of the barriers for women in science. I had found it highly relevant and a very important argument to add to the struggles and challenges that women face in science careers. She, on the other hand, could not remember saying it and asked not to be quoted. She then said to me, and this is something I have never forgotten:

> The one thing I wanted to say was, *you* must, as you're doing your thesis and your data, also not disregard your own space that you're in when you observe.

I indent this because it has become a guiding force as I write and develop theory from my observations. This was an important moment in my ethics as a researcher because it asked me to interrogate *my* "behind-the-scenes" and what I, as a researcher, care about. Bruno Latour (2004) refers to this as "maters of concern," and Maria Puig de la Bellacasa (2017) calls this "matters of care," concepts that I discuss in detail in Chapter 2 and Chapter 3. The visible gendered gap that I observed in the division between women scientists inside the laboratory conducting experiments and predominantly men in senior positions, my own position as a woman, and being the daughter of a medical scientist who has overcome many obstacles because of her gender led me on an inquiry into women in science. I was determined that my research would contribute to interrogating the patriarchal institutional culture of science, that I would show how the laboratory was an extension of society and, therefore, a great space to think about societal gender politics and sexism.

I wanted to situate my research within important feminist STS scholarship from scholars such as Naomi Weisstein (1977), Donna Haraway (1985; 1989, 1991), Sandra Harding (1986, 1991, 2008), Londa Schiebinger (1989, 2003), Evelyn Fox Keller (1997), Ruth Hubbard (2003) and Lucy Suchman (2007), and to contribute to discussions from scholars such as Evelyn

Hammonds and Banu Subramaniam (2003), Sue Rosser (2012) and Rachel Lee (2017). I also saw connections between my fieldwork and important texts such as Sara Ruddick and Pamela Daniels edited book *Working it Out* (1977) as well as Lynn Hankinson Nelson and Jack Nelson's edited volume *Feminism, Science and the Philosophy of Science* (1996). More current work in the field that I found highly relevant includes Maralee Mayberry, Banu Subramaniam and Lisa Weasel's edited compilation *Feminist Science Studies: A New Generation* (2001) that encompasses the work of scholars and scientists alike, the incredible collection of essays from various women scientists titled *Motherhood, The Elephant in the Laboratory: Women Speak Out* (2008) edited by scientist Emily Monosson, as well as that by Diana Bilimoria and Xiangfen Liang (2012)[19]. What much of this contemporary scholarship shows is that the literature on women in science from Naomi Weisstein (1977), Rita Arditti (1980), Evelyn Fox Keller (1977, 1985) and Hilary Rose (1983) is still shockingly relevant. Women scientists and academics still find themselves in subordinate positions decades later. Literary fiction such as Nnedi Okorafor's African Science-Fiction *Lagoon* (2014) and Hope Jahren's autobiographical novel *Lab Girl* (2016) also speak to some of the challenges women scientists face.

I wrote two chapters on these topics that spoke directly to this literature. Months of research, writing and re-writing. I wrote about identity politics laced onto women's bodies and the consequences thereof. This was sparked by Leigh telling me that she "would never give a presentation in like a dress or a skirt or anything like that." She said that she "would always wear like pants or a manly blazer or something like that" because "it seems more credible," so that she was "taken seriously." Leigh explained, "I want to be taken seriously and I'm so worried people will be like 'she's just trying to be sexy to get ahead' or anything like that. I always try and make sure, especially for presentations, I look as unfeminine as possible." I

[19] Much feminist work has been done to destabilise the objectivity of science and scientists, revealing how gender and sexism makes its way into the production of scientific results and knowledge (see Bleier, 1984, 1986; Hardy, 1981; Hubbard, 1990; Di Leonardo, 1991; Gero and Conkey, 1991; Martin, 1991; Fausto-Sterling, 1992; and Potter, 2001). Feminist scholars like Donna Haraway (1989), Eva Hayward (2010), Karen Barad (2012), Rebecca Jordan-Young and Raffaella Rumiati (2012) as well as Sophia Roosth and Astrid Schrader (2012) engage theoretically with science itself, provocatively pushing our understandings of science and technology through feminist insights. In some cases, scientists such as Amy Bug (2003), Margaret Conkey (2003) and Patricia Gowaty (2003) have contributed to this scholarship by showing how feminism has changed their respective scientific disciplines (see special section edited by Sandra Harding and Kate Norberg in *Signs: Journal of Women in Culture and Society*, 2003, 28(3)). Along similar lines, feminist scientists like Marta Wayne (2000) and Deboleena Roy (2008) have given personal accounts of their disciplines and their experiences as scientists.

wrote about an experience where a participant received little respect from male clinicians and another experience where a participant had to "prove" she knew what she was talking about to a group of male engineers before they would look at her in a meeting. Leigh said, "I do think women have to work a little bit harder to be accepted as knowing what they're doing and being an authority on something." Grace spoke to this when she said, "That's just the way the world is. People just respect men more. They think men are more capable. So, it's like a default setting." I wrote about men getting more recognition than women, as Alison pointed out, using the example of a man in her research group who only pursued his own project and was not involved in other projects. "Still, he gets praised, 'he's so good,' 'he's just such a great…,' 'he's developed so much' … We have so many amazing scientists within our division that do so many great things, but they are never acknowledged," Alison said in an interview. "Those people that you're saying [who do not get acknowledged], are they mostly women?" I asked in response to Alison. Alison laughed and replied, "They are all women."

The difference between men and women's workloads and commitments beyond immediate research projects was something that many of my participants discussed (see also Prozesky, 2008). I was told that women take on more because they were "too nice," because they felt "bad" or "sorry" for the person asking for help, "because men just refuse to do it," "because it's a woman's job, you know," because "if something comes up the man will just sit back and then the females are like 'let me just… so that it just gets done,'" because women "feel bad about saying no" or "guilt" about saying no, because "I don't want people to think I'm lazy," or because "they feel they need to prove themselves." The idea that women were "too nice" also came up when Leigh discussed not "trampling on any toes." She was careful that her research did not enter the territory of another researcher, even though they were both working on the same area of research. "To publish… you can't be nice," she explained. The converse, as it was explained to me, is that if women are not nice, that is, they are assertive, they are labelled "a bitch." This was what one of my participants told me she had been

called[20]. I wrote about an example of a gendered wage gap, which was brought to my attention from more than one of my participants. Alison explained "there is someone, also a scientist, a postdoc that only does his project… same level as me, got his PhD one year earlier than I did. He gets a higher salary than I do." This is not uncommon in the sciences (see van Staden et al., 2019)[21].

I also wrote about silence and voice after Marina said that she had noticed in meetings that women were more reserved and voiced their opinions less than men. Alison spoke to this observation when she said that "there are times when we're sitting in meetings and it's a very senior PI [Principal Investigator], a woman would speak about things and there would be this debate between her and some senior males and like the woman sort of sits back and stuff"[22]. Emily discussed her time in Zambia when she ran a laboratory and how she had to "sit back" even though she was in a senior position and had more expertise than many of the men around her. Marina also spoke about how women always wanted to make sure that everything and everyone was okay. Marina gave the example of how she and her female Principal Investigator (PI) spoke with each other after meetings to make sure that they had said things "in the right way."

I also wrote about the challenges of having a career and having a family. This had to do with how women's "dual role" (Managa, 2013) as career-woman and mother, and the way in which institutions are set up, makes it difficult for them to fulfil the expectations of those roles. This is where gender becomes important in this chapter – in relation to the timelines of women's

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[20] I am reminded of Sylvia Tamale and J. Oloka-Onyango's (1997) provocatively titled article "Bitches at the Academy: Gender and Academic Freedom at the African University." Here, the term "bitch" was assigned to one of the authors for speaking out, that is, for having academic freedom. Relatedly, Mamokgethi Phakeng writes, "talented women are often constructed as ambitious rivals; and gender politics harshly depicts them in patriarchal stereotypes, caricaturing their personalities to curb their influence" (2015: 2). This is indeed a challenge that women face in academia.

[21] Sarah Gilbert, Professor of Vaccinology at Oxford University and designer of the ChAdOx1 nCoV-19 vaccine, spoke about how 67% of the scientists on the first scientific paper their team published were women, but the men on the paper earned 10% higher than them (UNESCO, 2021).

[22] Antoinique van Staden et al. note from a panel discussion at the 2nd International *Women in Science without Borders* conference held in Johannesburg in 2019 that it was felt that one of the reasons for the gender pay gap amongst scientists in South Africa was that men were "more assertive," found "it easier to talk about their own accomplishments and behave as better self-marketers" and it was agreed among the panelists that "female scientists need to develop the skill and confidence to be able to negotiate for pay increases" (2019: 34). I highlight the connection between gender, voice and confidence on this page, in relation to Emily's and Marina's experiences.

scientific careers. I explore this shortly in a section dedicated to gendered time and temporalities. Although it is clear that gender politics existed, and they are highly important to interrogate, my participants discussions of their careers did not revolve solely around gendered experiences.

As I started weaving this thesis together, I realised that my concerns had put me in the very position for which I have critiqued science elsewhere in this thesis, particularly in Chapter 3. My research and my questions spotlighted gender where it might not have been discussed otherwise or experienced in such terms. Like Grace said to me in a discussion we were having on gendered discrimination, "You actually can't tell." I recall Lesley Green, in an Environmental Humanities seminar I took with her in 2017, saying, "What you see blocks your sight." Francis Nyamnjoh has referred to this as "blinded by sight" (2012), which he uses to explain the "blindedness… which comes from preconceptions, prejudices and assumptions about what constitutes reality" (2012: 65). His argument is particularly about how "ethnographers… are so focused on their areas that they are, consciously or not, oblivious to the existence of other areas" (ibid). At the root of each of these assertions, is that looking to see or find certain things (often because of prior assumptions), blocks you from seeing or finding other things. In other words, from remaining truly "available."

I had remained available to care, open to all of its becomings, but I did not see how my focus on *women* scientists blocked me from seeing what actually mattered to my participants. It is not that I ignored what mattered to them, it was that my focus on women meant that I prioritised discussions about the experiences of being women in science. I looked and listened for clues that would help me write about exactly that. Being women in science – and the struggles and challenges they faced as women – mattered far less to them than being good scientists, producing good science and, for most of them, being involved in things that mattered beyond the laboratory. Leigh told me that she did not like the term "women scientists." She was a scientist, not a *woman* scientist, she said. "It makes me feel like I'm not on par with male scientists… How I can combat this is to be the best scientist, be better than my male counterpart," she explained (also see Phakeng, 2015: 2). As this shows, this is not to say that my participants did not face sexism in science or that they did not face obstacles because they were women. This is especially not to say that gender issues, gendered

inequality and gendered discrimination did not matter to them. This is also not to say that that research of this kind is not important or necessary. It is. Each of my participants struggled in their own way with what being a woman scientist entailed. The point is that for this particular research with these particular scientists, their concerns – or cares – went beyond gender. For this reason, I write about gender where I feel it is relevant, particularly in relation to women's career trajectories in the face of wanting and having children and families as well as the gendered dimension of care, but gender is no longer a guiding focus. In these discussions, gender grounds other important concepts in this thesis, such as time and temporalities.

I included this as part of the ethics chapter because this is exactly what ethics is about. Ethical research is about more than ticking the boxes that are supposed to be ticked to get ethics approval for research projects. Producing ethical research is not just about following ethical guidelines, getting informed consent, understanding the power dynamics between researcher and participant, protecting identity and confidentiality and upholding a "do no harm" approach. Ethical and responsible research requires being truly available to alternative becomings, to multiple concerns, to slow and careful thinking and theorising. It requires interrogating positionality and concerns long after the fieldwork is complete. And then interrogating them again. It means thinking about what the research means. And then thinking about it more. It means thinking about what matters to the participants. And then thinking about what *really* matters. This takes time. And patience. This is precisely why thinking through temporality became a major ethical and methodological tool and why I extend thinking around time to make an argument for slow science. I first started to think about temporality during my fieldwork.

TEMPORALITY AND IN-BETWEEN-METHODOLOGY

Throughout my fieldwork, I was asked by my participants and various scientists in the division questions such as: "How long are you here for?" "How many participants do you have?" and "How many more of these [lab observation sessions] do you have to do?" I was struck by the focus on time and quantity. I struggled to answer these questions because I could not put my fieldwork into time and numbers. This numerical and quantified reduction would not

accurately represent or portray the work that I did. The time that I spent on this research – thinking, preparing, reading, designing, planning, cultivating relationships with scientists and the division, forming and getting involved with science engagement projects, conducting fieldwork, reading literature, formulating arguments, presenting this research, and writing this thesis – has been six years in the making. I began conceptualising what I call "in-between-methodology" as a way to grapple with the complexity of the research and data gathering process, with its fuzzy boundaries around what "counts" as ethnographic data and when research is and is not "happening."

In-between-methodology began when I kept hearing that what I was observing in the laboratory was "boring." Sometimes, it was while my participants were preparing for an experiment, other times it was during a certain stage in an experiment. Sometimes, it was when they were making media to clean and feed their cells or bacteria. Again and again, my participants would tell me that I was watching the "boring" part. Grace defined only the part where she infected the macrophages with the bacteria as "active research." That was when she felt that the research was "happening." This did not include the hours of labour that went into preparation, growing the cells, preparing the media, and so much more. These hours were not counted. The late nights spent inside the labs, the early mornings or the coming in on the weekends were not counted either. These were the moments in-between active research.

Grace sparked my methodological imagination and pushed me to think about when my research was "active," when anthropology was "happening." The intriguing insights and reflections from my participants came in moments when they were least expected, particularly in the moments when science was thought to be *not happening*. At the start of fieldwork, I became fixated on documenting the science that was "happening" in front of me. I quickly realised that the most valuable ethnography came during the preparation of an experiment, during the waiting between experimental protocols or between experiments, when I walked in the corridors with my participants on our way to the labs, when we were putting on our protective gear in the "clean room" before we entered the P3 or when we were waiting for the autoclave machine that washed all of our gowns to finish its cycle at the end of the day. These moments were precious and were an important part of data gathering.

It was in these moments that I learned about what my participants' families' thought about their work, about the challenges of having a career and having a family, about their passion for the work they did, about what they did beyond the lab, about the poor living conditions of the cows they had drawn blood from, about how to treat lab rats well, that pipettes were "weird" or that it was tough to find a husband.

In fact, I learned a lot in the "clean room" or "ante-room," as it was described to me by the BSL3 manager when I entered the BSL3 for the first time. It was the space between the offices and labs of the division and the BSL3. To get into the BSL3, you needed to enter a negative pressure room. The negative air pressure ensured that contaminated air inside the BSL3 would not move to the "outside." Hence the name, "clean room." In this case, the outside was the corridors, offices and laboratories of the division. The clean room was where we changed into and out of our protective clothing and gear when we entered and exited the BSL3. Getting ready to enter and leave the BSL3 required a strict protocol of protection, including gloves, gowns, scrubs, plastic sleeve protectors and Powered Air Purifying Respirators (PAPRs). PAPRs are worn in environments where there is a high risk of aerosol transmission of pathogens. They are a battery-operated air filtration system that is comprised of a battery pack worn around the waist, with tubing that connects to a mask or face-piece that covers your entire face and shoulders. Since putting on and taking off protective clothing and equipment involved a relatively lengthy process, there was a lot of time for conversation in the clean room. The clean room was quite literally a physical manifestation of the in-between as a time-space where much happens.

In-between-methodology encapsulates the rich material that comes in-between, during the waiting, during the "boring" stages, during the moments between events. It is between the carefully thought-out methodologies, in the moments when I was not looking for "data," when I did not have my notebook, when I was driving in the car with a participant or when I was changing out of my gown. This methodology is all the "stuff" that we do as researchers that is hard to articulate in a methodology section. It is the time that is not included, but it is all about the time that we spend on and in our research. In-between-methodology is a state of the in-between, but not a state of nothingness. This is the sitting-with. The sitting-with our participants, our fieldnotes, our readings, our theory, our writing. In-between-methodology

describes the mental incubation period too. Incubate is an interesting word because *Mtb* and cell cultures also needed to incubate. They were put inside incubators to grow. Research did not stop in these periods. In these moments of waiting, sitting-with and incubating, research grew too. Bacteria were infecting macrophages, chemical reactions were occurring, lines were being expressed on x-ray film, bacteria and cells were growing and dying, experiments were working or failing, careers were being made. This taught me that research was always happening. For me, this means that "the field" – the place where anthropologists go to do research – is never separate from "outside" of it. As Sharon Macdonald writes, "the boundaries between 'research' and 'not research' are often unclear and fluid" (2010: 81). Since in-between-methodology breaks this imagined boundary, it points to the need for methodological openness, the spontaneity of data gathering, since research is happening at every point. As will become clear, the porosity and breaking of boundaries is a trend that spans the length of this thesis.

There is something significant about theorising the in-between, not only for the methodology of this research, but for science. Anthropologists Natasha Myers and Joe Dumit (2011) write about science and the in-between from their research with biologists. Their participants are continually "in the midst of things: caught up in moments of not yet knowing" (Myers & Dumit, 2011: 241). They therefore "offer… an anthropological phenomenology of those sometimes fleeting, sometimes prolonged moments that arise in the middle, mid-thought or mid-gesture" (ibid). The middle, the in-between, is an exceptionally interesting conceptual space. Tim Ingold has written that "the in-between is the realm of the life of lines" (2015: 147), where things *become.* It is a space not of stasis, but of movement, "where things are not yet given… but on the way to being given" (ibid). In the moments of in-between, things are indeed happening, moving, becoming. Maria Puig de la Bellacasa has connected care to the in-between, suggesting that "Care is embedded in the practices that maintain webs of relationality and is always happening *in between*" (2017:166, emphasis added). Care, therefore, defines "the *whole* of a situation" (ibid, emphasis added). Chapter 2 tells the tales of care inside the laboratory. What is significant about making the in-between matter is that it calls attention to both care and the forgotten or neglected labour that scientists do in-between. It was precisely what was left out, forgotten and neglected – the gaps – in the final scientific outputs that interested me; the behind the sciences of science.

Science was *always* happening. The in-between allowed me to conceptualise science as the *whole* of the situation. This applied to my research too. In relation to the dilemma of "what you see blocks your sight," in-between-methodology meant that everything was potential data. Using only carefully thought-out methodologies as avenues to collect data, blocks the inclusion of potentially and highly relevant data. By theorising the in-between, I hope to connect the dots of science, care and my methodology. From the outset of this research, I sought methodological, ethical and conceptual alignment so that the methods, ethics and argument would coproduce the knowledge of this thesis. The in-between is a beautiful space for that to happen. I trace its connections to care in the sections that follow, especially in relation to time and temporality.

TIMESCAPES, CARE TIME, SCIENTIFIC TIME

The particular slow temporalities of *Mycobacterium tuberculosis* became apparent very early on in my research. "*Mtb* is a notoriously slow grower," I was told time and time again. Protocols would take weeks, if not months, to complete because of *Mtb*'s growth rate. It took about two months for each sputum sample to go through the entire protocol of Leigh's project to determine whether the patient still had TB. Leigh carried out this protocol for hundreds of patients. For all of my participants, experiments were sometimes postponed to give the bacteria more time to grow and lab sessions could be cancelled when they did not grow. I remember Grace's very sad face when she took out her culture flasks to begin an experiment only to find that the bacteria had not grown to her expectations. Since *Mtb* was a "slow grower," scientific research with the bacteria was slow. This bacteria's temporalities were at odds with what I call "scientific time" – the fast pace of science fuelled by its dogma of "publish or perish." As Isabelle Stengers notes, "The laboratory is now defined by the imperatives of gaining time, competition and speed" (2018: 38). This accelerated pace of science and the temporal tensions that emerged because of it are explored in the rest of this chapter.

Puig de la Bellacasa (2017), from whom I draw heavily in this section and throughout this thesis because of her rich and extensive theorising on care and attention to care within the framing of the "more than human," has written on temporalities in relation to soil. The

scholarship of Puig de la Bellacasa (2017) is a thread that knots this thesis in many ways. My thinking and theorising take much inspiration from her critical and engaged scholarship on care, which does significant work in extending the theory on care by her predecessors, as outlined in Chapter 2. Soil requires time to replenish so that it may be a valuable and renewable resource. This slower temporality, which Puig de la Bellacasa calls "care time" is at odds with "accelerated" industrial time (2017: 171 & 173). The latter is driven by intensified need for soil and profit, leading to soil exhaustion. Through these conflicting temporalities, Puig de la Bellacasa shows that there is "a diversity of interdependent temporalities of beings and things, human and not, at the heart of the predominant futuristic timescales of technoscientific expectations" (2017: 172). Puig de la Bellacasa (2017) provides a pathway to think through the temporal tensions between the multiple temporalities that are often at play. I noticed these multiple temporalities in Leigh's research. These multiple temporalities were made clear in Leigh's explanation of the timeframe of her research protocol for each sample:

> From the moment I get the patient's sample, I prep it. It has to go for at least 6 weeks, although I will continue it to 8 weeks, if it's negative. Then I have to grow them up which will probably take another two weeks, if it's going well. And then all the slides and stuff, I can do in the meantime. And then just to do the DNA extraction and the strain typing, maybe another week. So, you're looking at over two months for a result. And that's just for one sample. So, it does get a bit crazy to keep up with all of them. They're all staggered so, you know, some are coming up, some aren't.

Each of Leigh's samples was at a different stage of the two-month-long protocol that it had to go through to get a result. In one lab session, I could watch Leigh take multiple samples through different stages of the protocol – prepare one, plate another, make a slide from yet another. Puig de la Bellacasa writes, "the time of soil is not 'one'; it exposes multifarious speeds of growth becoming ecologically significant to each other" (2017: 213). These multiple and conflicting speeds of growth helped me think about time and the experiment, time and science, as well as time and care. Specifically, Puig de la Bellacasa's (2017) work made me think about human time in relation to different species. Drawing on Astrid Schrader (2010), Puig de la Bellacasa explains that "What seems slow or backward when living according to

human timeline or timescale might have a different sense in another" (2017: 214). Puig de la Bellacasa (2017), therefore, argues for the importance of acknowledging the multitude of temporalities by which various more than humans live by. In the scientific research that I observed, the slow nature of the bacteria required attention to more than human time, a timescale that operated at a different pace.

Puig de la Bellacasa uses Barbara Adam's (1998) concept of "timescapes" to think with time and care time, and the various conflicting temporalities that animate them. According to Adam, "Thinking with timescapes, contextual temporal practices become tangible" (1998: 10 in Puig de la Bellacasa, 2017: 173). In the context of this research, the concept of the timescape made tangible temporal tensions in many iterations. Some of these were the tensions between the length of experiments, the demands of science and the slow nature of the bacteria. *Mtb*'s growth rates were at odds with the fast pace of science. The time it took to care for the bacteria – the slower-paced care time – was, therefore, at odds with scientific time. This time was slower, not only because growth was slow, but because care time has a different temporal dimension.

The temporal tensions with TB are not confined to the scientific laboratory. "To cure TB takes *a lot* of time," explains Kate Abney (2020: 70, original emphasis). In a heartfelt chapter, Abney (2020) writes about the multiple temporal tensions of TB care that she observed during her ethnographic research inside a paediatric in-patient TB treatment facility in Cape Town, South Africa. Abney uses the phrase "TB time" to refer to the conflicting temporalities "between rigid TB treatment regimes, hospital rhythms and socioeconomic conditions" (2019: 71). The objective, quantifiable and rigid TB treatment regimens were at odds with the messiness of "hospital time" (Abney, 2019). Hospital time encapsulates the disparate timescapes of in-patient treatment articulated by bureaucracies, socio-economic circumstances, hospital resources, treatment delays and individual patient contexts (Abney, 2019: 71).

Back inside the laboratory, the slow timescapes of the bacteria meant that my participants would have to *make* time for *Mtb.* They would often keep cultures or plates "just in case." Leigh said, "I'm a hoarder. I don't throw things away until I'm 100% sure there is nothing there… sometimes they come up later. *Mtb* is a notoriously slow grower." This care time –

the slower temporality that was required for the bacteria to grow – was at odds with scientific time. Emily told me about the temporal tensions between care, academic work and finishing her degree. “I love them [the rhinos] and everything, but I also want my degree,” she said. She had to manage the pressures of her PhD work and the lengthy and tedious process of recording and reporting the rhino test results for the wildlife park. Grace also spoke to the tensions between care time and scientific time, highlighting the difference between the slow pace of careful research and the expectations in the world of science:

> I know one thing, my supervisor doesn’t really say it, but he also thinks I’m *too particular*… In my head, I want to do everything right. I want to do everything the right way. So, it took me quite a while to, like, I presented an article in [a group literature meeting] like the work there was… something I could obviously do, but I’ve spent so much time trying to get my techniques right, trying to do it the right way, trying to do it the good way, trying to make the infection as natural as possible. So, for example, some people infect with freezer stocks. Like they infected frozen. But then I want to grow up the bacteria, make sure the bacteria is alive and well. But that also takes time. Like sometimes I want to infect, but the bacteria didn’t grow. I have to cancel my [experiment]… But also trying to do things the right way, the best way possible, also delays you. And then you see that some other people just do the experiment. They are able to get results faster. And I’m like, I have to wait all this time to try and do things the right way. I’m not getting as much output as I would want to get. So, I’m just like, should I just do? But then at the same time, if you do experiments as fast as possible people also criticise you. People who know the work will start asking you questions. Why didn’t you do this? But not everyone is doing it.

Grace’s reflection is rich with the temporal tensions that were at play in her research. Taking time “delays you” and it slowed down the time it took to get results and outputs. But Grace was set on taking time “to do it the right way,” “the good way.” She wanted to operate at the timescape of the bacteria, “to make the infection as *natural* as possible,” not at the accelerated and anthropocentric scientific timescape whereby “people infect with freezer stocks. Like they infected frozen.” She opted to “grow up the bacteria” before they were infected. Grace’s slow approach was not valued; she was “*too particular.*” It was considered

unproductive specifically because in the world of science, publications are held up as the measure of scientific productivity (Prozesky, 2006, 2008).

This slower-paced care time "is made irrelevant from the perspective of the progress-oriented, productionist, restless futurity" (Puig de la Bellacasa, 2017: 206). And, unfortunately, "productionist" time defines the present technoscientific moment (ibid). Thinking about time in this present moment is therefore thinking about fast-paced capitalist, productionist, profit-driven, results-driven time. Care time is considered unproductive in comparison to this (Puig de la Bellacasa, 2017: 177). The conflicting timescapes between care time and scientific time becomes important again in Chapter 5. What my participants cared about was at odds with the fast-paced, publish or perish spirit of science. Since care time is not seen as productive time, these conflicting timescapes also become important again in the particular timescapes of women's scientific careers, which I turn to shortly. But first it must be asked, is care time really unproductive?

OPERATING DIFFERENTLY: CARE TIME, PATIENCE AND DISRUPTION

Milton Mayeroff, one of the first theorists of care, writes that:

> Patience is an important ingredient in caring: I enable the other to grow in its own time and in its own way… Patience is not waiting passively for something to happen, but is a kind of participation with the other in which we give fully of ourselves. And it is misleading to understand patience in terms of time, for we give the other space as well (1971: 12).

I have discussed what happened in the in-between, the "waiting," the "boring" stages that were thought to be unproductive. I have described how these moments were far from unproductive. These in-between moments were patient, slower moments, but abound with activity nonetheless. As Mayeroff explains, the threads between temporality, care and patience are entwined. Mayeroff's discussion of patience is not only through the lens of slow activity, but co-participation whereby the other is given "room to live" (1971: 13). Interestingly, Puig de la Bellacasa conceptualises "care as the fostering of the endurance of objects through time (maintenance against breakdown)" (2017: 171). My participants would,

quite literally, give their cells and bacteria room to live, fostering their growth, allowing time and space for their particular temporalities so that they endured through time. In these moments – which could be weeks or months – they were protected against the ultimate breakdown, death.

But these moments required that my participants be patient with themselves. Mayeroff writes, "But, besides being patient with the other, I must also be patient with myself. I must give myself a chance to learn, to see and discover both the other and myself; I must give myself a chance to care" (1971: 13). Grace took her time to do it right, giving herself a chance to care, and getting behind on publications and results because of it. Leigh gave her samples an extra two weeks if the result came back negative. Far from being "unproductive" or passive, as care time is seen to be, patience – which I see as room for slowness – is extremely valuable. Care time, with its slower temporalities is about "operating differently" (Puig de la Bellacasa, 2017: 212). By operating differently, dominant timescapes are disrupted.

Puig de la Bellacasa argues that care time is disruptive. Care time involves "a lot of… adjusting to the temporal exigencies of the cared for" (2017: 206). This adjusting means changing, shifting to different temporalities, slowing down. Since care time is slow time, it requires "making time" (Puig de la Bellacasa, 2017: 177). Because care time is in opposition to the dominant future-driven, accelerated and fast-paced time that characterises our present moment, it is disruptive (Puig de la Bellacasa, 2017: 172). Slowing down is disruptive. This time perspective becomes important for decolonising science. If care time is considered unproductive, then "making time" for it is disruptive. In this way, my participants disrupted the fast pace of science and created a different kind of science that saw value in slowing down. This comes to matter very soon in my argument for slow science, but I first need to apply care time and *slowing down* to my own methodology.

SLOW THINKING, SLOW RESEARCH, IN-BETWEEN THINKING

In her book, *Rock, Water, Life*, Green writes about the significance of slowing down and the kind of connections it enables:

> Cycling around the peninsula, weekend after weekend, taught me that what I have been taught to see, and what I expect to see, and what I have learned to name and connect, did not give me the tools to "think" the connections that my bicycle was making, *slow spoke by slow spoke* (2020: 5, emphasis added).

At every step of the way, I thought about my own research in the same way I did with the scientific research that I observed. As I moved away from what I expected to see, learned to name and connect, I realised that I needed to think differently. I needed to "navigate the slow stuff" (Green, 2020: 12). This kind of thinking, questioning and navigating became part of my methodology, *because methods do not end when fieldwork stops*. How data are organised, constructed and made to speak alongside literature from other scholars to produce theory is also part of the methodology. A different way of thinking became a very important methodological tool, particularly because as I moved away from focusing mainly on gender, I became available to the very particular and exciting ways my focus on care and the various human and more than human relationships inside the laboratory and beyond it could speak to the calls for decolonisation.

Following Green, "sometimes it is helpful to work with the spaces between things, not just the thing itself" (2020: 19). In-between thinking became a methodological process that I adopted to explore these spaces between things, the gaps. This extended my in-between-methodology to my thinking style. Importantly, this involved "thinking athwart" (Green, 2020: 19). "To think athwart an established concept may seem to some to choose a state of drift. Yet conceptual drift can be a lifeboat where inherited concepts themselves are sinking vessels," Green explains (2020: 19). Drift was an important element in this work. It made room for thinking differently and reimagining. But it also involved getting lost. Throughout this research and the writing up, I got lost. I got lost in the weaves of my tapestry, I got lost in my thoughts and the thoughts of those thoughts. But getting lost is important. Especially while conducting ethnographic research, because it means that you learn things you otherwise would not have. As Green writes, "When you're lost, you retrace your steps, as best you can. Go back to places you've seen before; exploring the routes in and through them again. Ask: How did we get here? What pasts are present, and what futures are forming? What

connections exist that I didn't see before?" (2020: 6). Drifting and getting lost are important processes of good research. Significantly, they require time.

Each of these methodologies of thought, vital for producing ethical research, required slow temporalities and patience. Like Grace, I wanted to do things "the right way," and like Grace said, that takes time. Like Leigh waited for the bacteria on Petri dishes, I waited to make room for the thoughts of this research to grow, thrive and flourish to produce good "results" – theory. The temporality of this research mirrored the points I have raised in this chapter. This also meant that this research has involved a particular care-time. For Liza Grandia, "Slowing down ethnographic research… might help to create the kind of disruptive 'decolonizing space' advocated by Maori scholar Linda Tuhiwai Smith" (2015: 312-3). The connections between slowing down, disrupting, creating space and decolonising are highly relevant for the arguments that I weave in this thesis. These themes are also relevant to the particular timescapes of women's lives and careers.

GENDERED TIME AND TEMPORALITIES: THE PACE OF WOMEN'S CAREERS

According to my participants, having a successful scientific career – successful in terms of what science counts as successful such as "major publications," as Leigh said – required time. "You've got to work at night or on the weekend. And there's a lot of push for, like if you're not doing that as a scientist, you're not successful… But the reality is that very successful people do not have lives. That is the reality," Leigh explained. Alison also noted the demands of scientific careers that were explained to young scientists:

> And I think it's also the way that we teach the younger scientists. So, I've seen male scientists teaching younger female scientists or even any supervisor teaching a young scientist about: you have to be in the lab from 6:30 until 19:00 tonight and you need to

> work Monday to Sunday. And if they take off a Friday? Why do you want to take off a weekend?! [23]

A scientific career is a fast-paced career. Leigh said that "you have to always be doing something if you want to stay ahead. I just feel like that's science. There's so much competition that you better keep swimming or else everyone's going to take over." She also noted, "I think a lot of scientists don't switch off. You've got to go home and work on your grant, work on your paper, work on this, and analyse some data. It doesn't end at four thirty." At the core of these discussions was that a successful science career requires time, and *all* of one's time (see Ledford, 2011). For women, this means that *finding the time* to have and care for children can be tough if the goal is a successful career in the fast-paced world of science[24].

At the time of my fieldwork, Grace was engaged and planning to get married and start a family:

> That's what I've been thinking about this week. And like children, yeah, *when?* Probably I have to finish my studies first before. Well, I guess I knew all of that before I decided I wanted to be in the TB field. So that's fine. But just something I have to think about.

Grace and I were sitting at the campus coffee shop, talking about starting a family while pursuing a career. "So even if I wanted to [have children], I can't," Grace explained. Pregnancy posed particular kinds of slowing down for women scientists working in the field of TB, where research was predominantly conducted inside the BSL3. During the time I conducted my fieldwork, pregnant women were not allowed to work inside the P3 because of the risk of infection that conducting research with *Mtb* might pose to them and their unborn baby.

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[23] There is an interesting comparison between a female- and male-run lab published in *Nature* (2011). Julie Overbaugh stresses the importance of work-life balance (2011) while Alfredo Quiñones-Hinojosa runs a "24/7" lab, expecting his scientists to work long hours, on Friday nights and on weekends (Ledford, 2011). But as all of my participants stressed throughout, there were always sacrifices. "The area in which I have failed the most is as a father," Quiñones-Hinojosa says to Heidi Ledford (2011: 22). Analysing what gendered differences in leadership could mean for the culture of the lab and the pace of its science is beyond the scope of this research, but these examples point towards an interesting field of inquiry to further understand gender, science and (gendered) time. See Overbaugh (2011) and Ledford (2011).

[24] For quantitative research on the gendered gap in scientific publications, see Luke Holman, Devi Stuart-Fox and Cindy Hauser (2018).

Marina waited until she was twelve weeks pregnant before she told anyone because she did not want to be stopped from working inside the BSL3. She was not alone; I was told about other women hiding their pregnancies for a few weeks while they finished up their experiments in the P3[25]. After twelve weeks, Marina asked to be allowed inside the P3, but her request was denied. Marina was devastated. She worked with a specific strain of *Mtb,* which was a non-pathogenic strain that could be used outside the P3. Marina explained that she and a colleague had worked hard to publish a paper that showed how similar this strain was to *Mtb* and how it could be used if researches did not have access to BSL3s.

When I asked Marina whether she had to make any sacrifices to get to where she was in her career, she said that she sacrificed having another baby, putting it "on hold"[26]. She explained that making the decision to have a baby was a difficult one because it would mean a year of not working in the P3 and compromising the obligation to funders to finish research in a certain number of years. Marina worried deeply about "letting people down." She thought a lot about what the senior scientists would say if she had to tell them she was pregnant. During my fieldwork, Marina was applying for two funding opportunities, one of which was moderated internally. This worried her because, as she explained to me, the division knew her and her family situation and might ask whether she planned to have another child. She felt that might affect whether or not they gave her the funding. At the time of my fieldwork, Marina was navigating her husband's desire for another child, her career and her obligations to funders. This was very stressful for her.

Alison and her husband also wanted to have a baby. At the time of my fieldwork, she wanted to finish all of her research inside the P3 so that she could get pregnant. She added that P3 work was also not allowed when breastfeeding. To work around this limitation, Alison said that she would either do other work or get other scientists and students to do the P3

[25] In her research on women miners and Tuberculosis, Mutsawashe Mutendi (2017) spoke about women hiding their pregnancies in order to continue working in mines. Like working with *Mtb* in the BSL3, working underground in mines posed risks to pregnant women and their unborn babies. Although there were risks, women in both cases wanted to continue working. For the scientists, it was about not slowing down and keeping the pace of their scientific careers. For the miners, it was about the need to stay employed and earn money in the face of dire socio-economic circumstances.

[26] It is not uncommon for women scientists to postpone familial roles and responsibilities for scientific careers (see Prozesky & Mouton, 2019 and Campion & Shrum, 2004).

experiments for her. After I conducted fieldwork, Marina told me that she put a case forward to the biosafety committee to allow pregnant women to work in the BSL3. In her email to me she wrote:

> *You might find this interesting, but I have managed to arrange that pregnant women will still be able to go into the BSL3 to work while being pregnant (this was no easy task, but totally worth it!)… This is of course by choice and no women should feel obliged to do so, but I am super stoked to be able to continue my work in the BSL3 facility during this time.*

This was a huge obstacle that she had overcome and one that would benefit many women pursuing their careers in this division. Marina has since had her second baby, and Alison her first.

Navigating the timelines of pregnancy in relation to career trajectories is one aspect of starting a family, but maternity leave posed further challenges to women's career timelines. Alison explained that postdoc salaries and timeframes did not generally allow for four months off – the period of maternity leave in South Africa according to South African labour law – and a four-month extension. Leigh expressed the consequences of this when she said:

> You are expected as a woman, like you're going to take some time off sometime. And so, many postdocs, like they don't have maternity leave. So, when they go on maternity leave, your fellowship carries on and then when you are being reviewed, they are like 'why do you have this huge gap here? What were you doing this whole time?' And saying you had a baby is not accepted. I mean that's shocking.

Many of my participants compared this challenge to the experience of a male scientist having a baby. Alison noted:

> So, there is that challenge, whereas a male doesn't have to take off that time… a male doesn't have that. He goes home and he comes back to work. If he's that kind of male, the wife will take care of the child or when he's at home, he'll take care of the child. But then he'll work from seven to six or whatever. So, that's one of those things.

Each of my participants spoke to this differing gendered timescape and suggested it could be a reason why there were fewer women scientists in senior positions. Grace said:

> I think one thing that plays a role is family. Women having babies… So, all the time they have taken off on maternity leave, the men are getting ahead. So, it's possible that the men are more qualified to be in the senior posts, but there's a reason for that. Women have to sacrifice a lot more, family wise. I think that's one reason. Men, they are just more, they can focus entirely on their career and it's fine. They are able to. They don't really have a lot of [family] responsibility.

Leigh also pointed this out when she said that "men should also get like parental leave, paternity leave and things like that, but they don't have that. They can come back almost the next day and carry on working." This is why "Men don't have that same thing, so they're just continually advancing while you're at home taking care of the children," as Leigh expressed. Marina said that a man does not need to make the same kinds of sacrifices as a woman. The word "sacrifice" came up in many conversations with my participants on this topic. Women had to sacrifice *something*, Leigh explained:

> I feel like you have to make some sacrifices. One or the other is going to have to… Some people can do it, but I feel like they are the exception. In general, I think that is a huge barrier. Taking time off to have a family is going to slow down your career. There's like no way of getting around that…. Ideally, you can strike a balance, but something is going to get sacrificed. You cannot have your time be as dedicated to your science. If you want to be a successful, a very successful scientist, like a PI of a big lab, you have to make sacrifices. So, you can be like 'I'm ok with not being like the head of whatever and not getting all these major publications.' That's fine too. But then you're not going to get to that point.

Having a family does not, therefore, affect a man in the same way. This stems from gendered roles and responsibilities. As all my participants pointed out, women scientists and academics bear the brunt of the domestic roles and responsibilities (see also Rose, 1983; Tamale & Oloka-Onyango, 1997; Mama, 2003; Monosson, 2008; Prozesky, 2008; Prozesky & Mouton, 2019). This often negatively affects their careers (Tamale & Oloka-Onyango, 1997; Mama,

2003; Tsikata, 2007; Anagbogu & Ezeliora, 2008; Tettey, 2009; Akinsanya, 2012; Atuahene & Owusu-Ansah, 2013; Hassine, 2014; Raburu, 2015; Ngila et al., 2017; Prozesky & Mouton, 2019). Based on an online survey from five thousand African scientists, the major disparity between men and women scientists was the challenge of balancing the demands of work and family (Prozesky & Mouton, 2019).

Owing to this, women scientists' careers do not follow "the linear (masculine) norm for academic careers" (Prozesky, 2008: 57). Heidi Prozesky (2008), in her interviews with women and men scientists on their career trajectories, observed that women followed a different pace by postponing scientific careers for familial roles and responsibilities. As Dorothy Ngila et al. noted, women scientists often have "*gaps* in their scientific career as a result of the work-life balance" or "career *interruptions*… as a result of family responsibilities" (2017: 5-6, emphasis added). In turn, women scientists find themselves needing to "catch up" to their male colleagues, as one of Prozesky's participants noted (2008: 58). Leigh said, "I have spoken to some PIs who have told me it was hard, and they did have to sacrifice, and there was a gap in their careers where they should have been productive, but they weren't. But they were happy to take that hit." These gaps often mean that women need to "wait their turn" to move up the scientific ladder, further slowing down the pace of their scientific careers (Ngila et al., 2017: 6).

That these periods are seen as "gaps," "interruptions" and times where careers "take the hit" is very significant. Not only does it reflect negative language that works against women, but it shows that making time for families is considered unproductive time for which women are punished. These gaps "look bad," Leigh pointed out. Again, the idea of the "gap" connects to the in-between, where it appears as though nothing is happening. This time is not valued because it is considered unproductive. Puig de la Bellacasa has shown how "the work of reproduction and maintenance of life has traditionally been considered marginal to value-creating work" (2017: 208). This weaves back to my discussion earlier on care time being seen as unproductive time that is at odds with scientific time. Care (time) is considered "reproductive" rather than productive (Puig de la Bellacasa, 2017: 171). As Leigh said, "There was a gap in their careers where they should have been productive, but they weren't." This time and its particular slower or "unproductive" temporalities sit in tension with the

temporalities of science and the fast pace of "productive" and "successful" scientific careers. This time is considered to hinder careers and is, therefore, considered bad for fast science[27].

This is perhaps why, as Emily noted, "Women that actually make it are by themselves." It was for this reason that she wanted something different and why she stated, "I do not want to become a Prof… I want to have a life. I want to have a family and they need my time." Relatedly, speaking about women who have "made it," Leigh said:

> Yeah, I mean if you look at a lot of the higher-up women scientists, and not just here I'm just talking in general, a lot of them don't have families. The ones that have really made it super high up. So that could be a factor, but then I know some very good female scientists who are mothers and who make it work somehow. So, I think it is a challenge.

The challenge is that to operate at productionist time, certain individuals have to fulfil the requirements of what Puig de la Bellacasa calls "biological" time (2017: 209), which is another element of care time. Care time is therefore both reproductive time and the time that is required to maintain life (Puig de la Bellacasa, 2017: 208). Care time is domestic time, such as "the reality of the boob" – as one of my supervisors with a young baby noted, – feeding and caring for children, fetching them from school, cleaning the house, or micromanaging so that these tasks of care are fulfilled by someone else. These tasks are most often allotted to women, showing the ways in which (work and care) time is gendered. I discuss this in Chapter 2. Not only is care gendered, but also raced and classed in particular ways. Productionist time in many cases, particularly in South Africa, relies on the exploitative labour of black female bodies such as domestic workers and nannies[28]. A common feature of middle-income homes in South Africa, these women fulfil the responsibilities of the care time that is needed for life to carry on. Productionist time is only possible because women and carers operate at care time, fulfilling its needs. But it is not always women who take on care roles.

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[27] Van Staden et al. urge for "parental and household labour" to be "acknowledged as productive time" (2019: 35).

[28] For scholarship on the topics of domestic care as it relates to gender, race or class in South Africa, see Jacklyn Cock (1980); Deborah Gaitskell et al. (1983); Olagoke Akintola (2006); Lund and Debbie Budlender (2009); Shireen Ally (2010); Francie Lund (2010); Tanja Bosch and Caitlin McLeod (2015); Bridget de Villiers and Michelle Taylor (2019); and Daniela Casale and Dorrit Posel (2021).

Alison spoke about a female Dean at the University of Cape Town who said in a presentation that she had a supportive husband who looked after the children at home when she had to work late. Leigh also had a partner who challenged the gendered stereotype. Leigh explained:

> I am lucky that my partner is willing to be a stay-at-home dad. He has even said that and I would full on go for that, but what about women who are in stereotypically gender-role relationships? Like I don't know if that's an option for them and are they just going to have to sacrifice their career?

Regardless of gender, the fast pace of a productive and successful scientific career is only possible if there is help with taking care of the everyday demands that need to be taken care of. Alison, who was thinking about these issues long before I started fieldwork there, suggested that the culture of the institution needed to change[29]:

> And it's also about what we make women think about themselves. I don't think we allow a space for women to be themselves, to trust themselves and to create a balanced life. So, women need lots of different things that men don't need. Or operate in a different way… So, I think… it's about creating the space. And we had a women's forum meeting… and the Dean of the Faculty was there and we were talking about a number of issues that have come up for women in this Faculty and one of them was childcare. And I made the point that the culture… of this Faculty is not family-oriented, it's not balance-orientated. It's all about your work, your outputs… So, unless we change the culture, and the culture doesn't allow for space for women to be women, you know, and to explore what it means to be a female scientist.

Alison's argument for "*space* for women to be themselves" and "*space* for women to be women" reminds me of Mayeroff's definition of patience as giving not only time, but "space as well" (1971: 12) or "room to live" (1971: 13). Childcare facilities at conferences as well as at work was an important part of Alison's solution to create a more "balanced" institutional culture that would allow women to succeed. Women scientists' mobility is hugely limited because of their primary role as caregivers in the household (Campion & Shrum, 2004;

[29] Alison also wrote a news article for a South African news website highlighting the challenges faced by women in science for International Women in Science Day.

Prozesky, 2007; Akinsanya, 2012; Prozesky & Beaudry, 2019; van Staden et al., 2019). Alison's suggestion was about taking care of the everyday demands that women who have children need to take care of so that they are able to have careers *and* families. Introducing childcare is about valuing what many women value – family. Institutionalising a "family oriented" and "balance oriented" culture would mean that women would receive the support they need so that they could dedicate more of their time to science (see Monosson, 2008; Prozesky & Mouton, 2019). In relation to time, it is that the culture of science is not patient. Alison's suggestion was about being sensitive to the timescapes of women who have caring or domestic roles and responsibilities (such as caring for children) and giving them space to build their careers.

I have discussed the timescapes of pregnancy and maternity leave, but I have not yet addressed the timescapes of being a mother and what this could mean for the time my participants spent on their scientific research. Leigh expressed her thoughts about what having a child could mean for her:

> It's hard to say that because I don't know if I ever wanted to have children. But definitely it is like a factor in that I know I will have to take time off. I'm going to have less freedom to say, work at night or work on the weekends… It's true, you know, like there's a lot of my postdoc friends who have children who are not going to come in at night or stay late, or come in on weekends because they can't. They have to go home and take care of their child. So that's definitely in the back of my mind. You know like if I want a really strong career and if I want to make it to the top, it's so competitive that maybe I don't have time for this. But I mean, I think I'm also someone who always wasn't really sure if they wanted children in the first place.

Children and families require *time.* A scientist in Prozesky's research noted that she "managed to publish quite well" because she did not have any children (2008: 53). Marina, who had a young daughter, explained that a lot had changed since she had had a child. She planned her work so that she was more practical, ensuring she did not "waste time." This meant that she could "put time aside" for her family. She would not work at night or come in on weekends unless absolutely necessary. But this meant that she felt she did not do as much work at night

as she would have liked to because she prioritised time with her husband and her daughter. She also made the decision to only do the vital work on weekends, saying “the world is not going to end.” She did, however, feel a lot of guilt about this (see also Prozesky, 2008: 52).

Realising the timescapes of motherhood and the potential impact that it would have on her career, Grace began practicing *making time*:

> Lately, as the wedding is coming closer, I’ve been thinking a lot about family. Like, so if I was married, if I had kids, and then if I wake up this morning and then probably, I have to do something, take my kids to hospital… What’s going to happen to research? How is that going to balance out with my research? And I’ve just been trying to intentionally make my schedule flexible. Like I don’t want to plan experiments all throughout my week, all through the weekend like I used to do previously. And then I have no free time. I cannot even do anything. Like yesterday I just took a day off. I decided to work at home and just act like I had a baby, just try to ease myself and be more flexible. Because, like marriage is also important to me. Earlier we spoke about marriage being more important, not more important, but marriage is also important to me because in as much as I want to be a scientist, I also want to be a good wife, I want to be a good mother.

Grace did not want the fast pace of scientific time. Being “a good wife” and “a good mother” mattered to her. A work-life balance also mattered to her. I explore this in Chapter 5. There are, however, women who are able to strike this balance to “make it all work.” Leigh spoke about a PI in the division:

> She's a wonderful scientist, she's brilliant, she has two kids, somehow she just makes it all work, you know. She had like a child and was back at work like two weeks later, writing grants, coming up with amazing ideas. And I always look at her and say it is possible, look… what she’s doing. So, I think it's important to have good role models. It is possible and you don’t need to be scared.

Grace also gave a positive example, which gave her “hope”:

> On Tuesday I was quite happy because I went into the BSL3 lab and I saw a senior researcher who was previously pregnant and during that time she couldn't go into the P3. But I was happy that I saw her. She was back in the P3, so it gave me hope. After the baby is born, after I few months, I can still go back. It's not like I'll be having a child every year, so I can still do it…. So maybe after my PhD. Hopefully by then our group will have Masters' students and PhDs that are already trained in the BSL3. So, it's not like if I don't go into the BSL3 nobody's going to do infections or anything.

Although my focus on gender no longer guides the direction of this thesis, navigating the timelines of their careers and their desires to have children and families was a reality for most of my participants. This was particularly because of their roles as women, carers, mothers or potential mothers. Their career paths were or could be temporally influenced by gender roles and responsibilities such as having and caring for babies and households[30]. In the fast-paced world of science, publications show productivity and performance. This is deeply at odds with biological time and care time. As I have discussed, women who want to have children have different timescapes to their male counterparts. This is exacerbated by the fact that women's fertility is within a much more limited timeframe in comparison to men. The time that women take to have and care for children and the implications thereof are some of the possible reasons for the gendered gap between scientists in the lab and those in senior positions. The need for slowing down and patience, so fundamental to the argument for slow science, would help to navigate this gap and bring some of the things that scientists' value into the culture and institutions of science.

[30] Most of us have seen first-hand how the COVID-19 epidemic has acerbated this for women across academia. UNESCO held a Zoom Webinar on the International Day of Women and Girls in Science on the 11th of February 2021 titled "Women scientists at the forefront of the fight against COVID-19" (UNESCO, 2021). Shamila Nair-Bedouelle, UNESCO Assistant Director-General for Natural Sciences, opened the webinar with a speech that spoke directly to how "The pandemic has hit women scientists harder" (UNESCO, 2021). Childcare and domestic tasks fall unequally on women and the gender gap in science increases. Professor Jennifer Thomson, President of the Organization for Women in Science for the Developing World (OWSD) spoke about the impact of COVID-19 for women scientists in the developing world, saying that women are publishing less "because women have the primary role of caregiving" (ibid). For literature on how COVID-19 has negatively affected women's scientific careers more than their male counterparts see Kyle Myers et al. (2020).

SLOW DOWN: AN ARGUMENT FOR SLOW SCIENCE

"The Slow Science Manifesto" was published in 2010 by The Slow Science Academy in Berlin (The Slow Science Academy, 2010) (see Appendix A). "Science needs time to think. Science needs time to read, and time to fail," the manifesto argues (The Slow Science Academy, 2010). This group of scientists ask for "room" for this to be done (ibid). They believe that "Society should give scientists the time they need, but more importantly, scientists must *take* their time" (The Slow Science Academy, 2010, original emphasis). Stengers (2018), renowned philosopher of science, takes issue with this manifesto. She points out that this manifesto does not interrogate scientific authority. In this manifesto, science is portrayed as the ultimate solution to the world's problems (Stengers, 2018). The authority of science is discussed in Chapter 3 and briefly in Chapter 6. Stengers also points out that the manifesto does not name from whom scientists are receiving pressure nor "who they need to be protected from" (Stengers, 2018: 98). Furthermore, Stengers challenges the manifesto's explicit longing for the past. "Slow science was pretty much the only science conceivable for hundreds of years; today, we argue, it deserves revival and needs protection," the manifesto states (The Slow Science Academy, 2010). In response to this, Stengers argues, "What we are in fact hearing here is the lament of the golden goose missing the Golden Age when scientists benefited from both autonomy and the respect due to their role in serving the general interest" (2018: 98). Stengers (2018) agrees with the premise of "slow science," but not in the way it was put forward by the manifesto. Stengers does not believe we must "go back to the past" or that society must "leave scientists alone" (2018: 109). In her book *Another Science is Possible* (2018), Stengers makes her own argument for slow science, to which I now turn.

It is important to point out that the argument that I develop for slow science from Stengers' (2018) argument is *not* about taking a slow approach to dealing with problems that require rapid scientific solutions, such as the COVID-19 or the TB pandemics. Slowing down is about re-thinking science as a whole to make it respond in ways that are *relevant*, *impactful* and *careful*. It is about questioning what "counts" in science, or in other words, about questioning what science cares about. Slow science, for Stengers, means "a deep break with the ideal of academic science shaped during the nineteenth century" (2018: 98), which was based on "the fast, cumulative advance of disciplinary knowledge along with a correlative disregard for any

question that would slow this advance down" (ibid). Stengers argues that we need "to gain something like the slow knowledge of the gardener as opposed to the fast knowledge of 'rationalised' industrial agriculture" (2018: 123-4). This "slow knowledge" is about producing knowledge that serves humanity, not industry. It is about responding to knowledge that lacks what Stengers has referred to as "balance" (2018: 112). Achieving this "balance" requires paying attention to all the "stuff" (Stengers, 2018: 24-26) that scientists may not think particularly relevant to their science, all the stuff that might be thought to slow it down or be a "waste of time" (Stengers, 2018: 38).

For Stengers, this involves "rethinking and reinventing scientific institutions" and pushing scientists to "think, imagine and connect" (2018: 125). Connection is extremely important. Firstly, slowing down in this context means creating particular kinds of relationalities. These involve "reweaving the bounds of interdependency" and "creating relationships with others that are not those of capture" (Stengers, 2018: 82). As this thesis progresses and the definitions of care are fleshed out, it will become clear that caring relations are those that have at their foundation deep understanding of interdependency and connectedness. Secondly, "rethinking and reinventing scientific institutions" requires connection between the laboratory and the world "outside." In this case, the connection between the lab and the world outside that is fostered by a slow science approach. Stengers calls for *another* science, which slows down and realises the consequences it has outside of the laboratory. This comes from scientists asking the "big questions" (Stengers, 2018: 38) that, according to Stengers, do not make their way into scientific research. These are the questions with which society is concerned. Stengers argues that "Speed demands and creates an *insensitivity* to everything that might slow things down: the frictions, the rubbing, the hesitations that make us feel we are not alone in the world" (2018: 81, emphasis added). Becoming sensitive, by slowing down, means acknowledging that science does not exist outside of society. Therefore, slow science would be science that is "affected" by the world in which it is embedded so that "relevance" to that world becomes a guiding force (Stengers, 2018: 42). In other words, it is science that is driven by what society needs and cares about. This concept is woven in the chapters that follow. This also becomes very important in the argument for decolonising science that is explored in Chapter 6.

Stengers suggests that another goal of slow science would be "to slow down the number of publications and to insist that referees take the time to judge whether an argument is well-made or if it represents only a partial result, without intrinsic interest, hastily published to get a few points" (2018: 52). This is not to say that publications are not important. This is about interrogating how scientific merit has become about the speed at which a scientist can publish rather than whether their research is relevant[31]. The question of what science cares about becomes important here. Does science care about problems that society faces or about publications? This question is threaded throughout this thesis, and will gain more currency in Chapter 2 where I discuss a debate that played out after a presentation that I gave and a subsequent email exchange I shared with one of the heads of the division. Following Stengers' (2018) argument, a fast science serves industry, while a slow science serves humanity.

Importantly, and this comes to matter for decolonising science, slowing down means dissolving the science/society divide that keeps science from engaging with different collectives. Slow science pushes scientists "to enter into new symbiotic relations with other collectives that have different matters of concern" (Stengers, 2018: 103-104). According to Stengers, "efficiency" has "cut or destroyed" relations (2018: 104). Slow science is therefore about weaving relations to allow for "thinking together" (ibid). Symbiotic relations, as is discussed in Chapter 2, are fundamental to care. And understanding symbiosis, or sympoiesis and holarchical relationality – as discussed in the Introduction – as the connected and mutual flourishing of various collectives is an important foundation of the pathway to decolonise science that I offer in this thesis. "Thinking together," another facet of slowing down, is precisely about understanding our entanglement and, therefore, the need to include multiple thought collectives. I have shown in the Introduction how "thinking together," as Puig de la Bellacasa (2017) has defined it, is thinking in the collective, especially the more than human collective. Thinking together gains currency in Chapter 6 since I argue that decolonised science is *relevant* science. That is, science that *thinks together* with the community.

[31] See Brenda Leibowitz and Vivienne Bozalek (2018) for an engagement of the Scholarship of Teaching and Learning (SOTL) in higher education in the Global South through the lens of Slow Scholarship. Their preliminary research study looks at the benefits of this model in South Africa and why integrating Slow Scholarship into SOTL can be important for South Africa at this particular socio-political moment.

Stengers (2018) argues that slow science embraces the "messiness." Embracing the messiness is embracing all the stuff that is often avoided, the stuff that is deemed non-scientific – the messy stuff (Stengers, 2018). It is embracing the stuff that separates the laboratory from society to weave together a science that is engaged and concerned, that cares. Stengers explains that the "symbiosis of fast science and industry has privileged disembedded knowledge and disembedding strategies abstracted from the messy complications of this world" (2018: 120). Getting rid of the "disembeddedness" – the severing – requires weaving science to the world in which it exists, so that it is embedded in and connected to that world. Before I progress with these concepts in the following chapters, there is a final section on the ethics of this research.

TEMPORALITY AND SLOW RESEARCH

The extended amount of time that was spent on this research meant that a lot changed from when I first started doing fieldwork. This was made very clear when I was asked by a participant not to quote something that she had told me. Opinions and perspectives change. "'Cultures' do not hold still for their portraits," James Clifford writes (1986: 10). This makes it challenging to produce anthropological research because the very act of writing ethnography freezes people and their words in time. This is precisely what anthropologists call "the ethnographic present." It is a tense that captures our participants in an eternal moment. As Abney notes, "Time and temporal experiences pervade and saturate not only the research presented here, but the anthropological endeavour at large" (2019: 73). Deeply aware of this, I switch between present and past tense to work with and through these tensions. The thesis and its theorising are written in present tense, in conversation with the reader. This forms part of the "thinking with" and "writing with" that I have discussed in this chapter. I make use of past tense to write the ethnography, ensuring that I remain true to the fact that this fieldwork occurred at a particular (past) moment as well as remaining available to the possibility that *everything could have changed since then.* This, however, does brings representation and the thorniness of interpretation to the forefront.

I often think about Puig de la Bellacasa's question, "How do those we study live with the way we think-with them?" (2017: 83). I was and am always concerned with what my participants

might think of my research. This brings to the fore the consequences of "studying up" or "sideways" (Nader, 1964, 1972). Laura Nader's argument for "studying up, down and sideways" came from her observation that "we find a relatively abundant literature on the poor, the ethnic groups, the disadvantaged" but "little field research on the middle class and very little first-hand work on the upper classes" (1972: 289). She urged anthropologists to "ask themselves whether the entirety of field work does not depend upon a certain power relationship in favor of the anthropologist, and whether indeed such dominant-subordinate relationships may not be affecting the kinds of theories we are weaving" (ibid). Her argument, which also involved studying the power relationships and dynamics at play between various groupings (Nader, 1980), stressed the importance of anthropologists interrogating *who* they conduct research with and *why*[32]. As I discussed in the Introduction, acknowledging my positionality in relation to those that are most often studied in anthropological TB research in South Africa meant that I wanted to contribute to this field in ways that shifted the power dynamics to study "up" and "sideways." This does, however, come with another layer of accountability.

My participants were deeply engaged with my work. They never missed a beat. They often asked what I was writing in my fieldnotes, how a conversation would be used, how I was going to piece together their stories with those of the other participants, what the voice recording would be used for, or how I would write about something we had discussed. My argument on care and science was critiqued and questioned – I explore this in detail in Chapter 2. A few of my participants engaged with some of my writing and shared their thoughts on it. Although this is how anthropological research should be conducted – "with" our participants rather than "on" them – the reality is that most is not. I integrated a slow science approach so that I thought, read and wrote carefully, keeping Puig de la Bellacasa's (2017) question very close throughout. Her question also meant that I had to confront the fact that social research is inherently subjective and situated, bringing my positionality to the fore.

[32] For more on "studying up, down and sideways" see Laura Nader Chapter 2: "Reinventing Anthropology in the Seventies" in Nader's *Letters to and from an Anthropologist* (2020) and *Up, Down, and Sideways: Anthropologists Trace the Pathways of Power* (2014) edited by Rachael Stryker and Roberto J. González.

As I highlighted at the onset of this chapter, I am deeply aware of my central position in this research and how it influences the focus that this research has taken, the kinds of questions that were asked and what was written down or "counted" as data. This eschews chances of objectivity and makes conscious my "pollutions" (Puig de la Bellacasa, 2017: 80). I wrote myself into the thesis as a way to acknowledge this. This is an ethical tool used to show my centrality in the production of knowledge. As Clifford notes about anthropological writing, "The writers 'voice' pervades and situates the analysis, and objective, distancing rhetoric is renounced" (1986: 12). Clifford Geertz wrote that "anthropological writings are themselves interpretations" (1973: 15). Foregrounding these admissions ensures that it is understood that this research is *a thoroughly subjective interpretation.* The writing style might therefore appear eclectic and possibly self-indulgent, but it is part of an ethically responsible approach. Having acknowledged this, it is time to put on our protective gear and enter the world of TB science.

CHAPTER 2 – THINKING WITH CARE: CARE AND SCIENCE IN MORE THAN HUMAN WORLDS

I did not learn about care through a book or a journal article. Long before I even knew that care was theorised in academia, I learned about it from my participants. I learned about it through their actions, through their bodies, through their attitudes and through their words. Care was not an abstract concept, nor a theory. It was an attitude, a value, a practice that was central to how my participants conducted their scientific research and themselves in the world. It was palpable in the way they used their pipettes, arranged their laminar flow cabinets, handled their bacteria, spoke about their macrophages, thought about their colleagues, worried about their mice, made friends with their rhinos, made their decisions, got excited about their research projects, and dreamed about their futures. Analysing Ludwig Wittgenstein's philosophy of language, Stanley Cavell writes about the connection between language and worlds, or what Wittgenstein called "forms of life" (in Cavell, 1979: 168). In learning a language, you are also learning a world (ibid). Paying attention to language and how it was used brought me into the world of my participants and gave me insight into their relationship with the "living tools" (Franklin, 2013) with which they worked[33]. The language that my participants used, rich with metaphors, to describe what I was observing was a doorway into the world of care and science.

Care has been theorised by scholars such as Milton Mayeroff (1971), Sara Ruddick (1980, 1987, 1998), Carol Gilligan (1982, 1987, 2011), Nel Noddings (1984), Anette Baier (1987), Eva Feder Kittay (1999), Kittay and Diana Meyers (1987), Joan Tronto (1993), Virginia Held (1995, 2000, 2001, 2002, 2004, 2006), Michael Slote (2007), Thom Van Dooren (2014) and Maria Puig de la Bellacasa (2012, 2017). This chapter connects, or weaves, what I observed in the

[33] I use "living tools" to describe the bacteria, cells and species with which my participants worked. Objectively speaking, they are the "tools" of the scientific research that I observed. However, in line with the multispecies root of this research, as well as my introduction to these more than humans through my participants and the language they used, their terms need to be sensitive to their aliveness, subjecthood and agency. Hence *living* tools. Wakana Suzuki refers to this as "the oscillation between liveliness and instrumentality of cells" (2015: 89). I also use the term "subject-objects" elsewhere for the same purpose. Though subject-object goes a step further, highlighting the breaking of boundaries between subjects and objects that is explored in detail in Chapter 4.

laboratory and learned about during my time with my participants with how care has been theorised by many of these scholars. How my participants cared and what they cared about is developed throughout this thesis. The point of this chapter, however, is to engage with the literature that defines care. As this chapter progresses, I argue that care became relevant beyond what I had originally thought. Initially, my interest was in care inside the laboratory, but during fieldwork, I saw that it was impossible to separate the laboratory from the world outside. My participants' caring extended far beyond the laboratory. I conclude this chapter with an argument for care as a disruptive tool that has the potential to reshape what science values so that it is both informed by and driven by what society needs and values. The product of this would be a science that is in service of the greater good for humanity. As I discussed in Chapter 1, this is an argument for (slow) science that is *relevant*, *impactful* and *careful*.

ON CARE: GROWTH, LIFE AND BABIES

Much of the labour in the laboratory was centred around the growth of cells and bacteria. In some cases, the cells and bacteria needed to grow to conduct experiments. In other cases, their growth was a variable in an experiment, such as to test whether bacteria were present in a sample. Whatever the case was, growth was a vital part of the science that my participants conducted and, therefore, a lot of care went into ensuring that the bacteria and cells grew.

Speaking about the cells with which she conducted research, Grace explained:

> So, I think when I started working with cells, I realised that they are sensitive. If you don't treat them right, they don't grow right. I think that now plays back to humans. You can't expect to just treat humans any way and expect them to be all good or respectful back to you. Like you have to accord them the respect you want. So, in my honour's year, I was still learning how to grow up the cells, how to treat them right, how to put them in the environment they want. So, I realised if I wasn't doing that they were dying, they were not responsive, they were growing slowly. So, it just made me realise you actually have to treat them well. Like think of them as humans, think of them as people with feelings. Just treat them well, treat them how you would want to treat a human and then they will respond better. I was probably forced to think about this because when I realised if you

> don't treat them well, the cells wouldn't grow, your experiments wouldn't happen, your research just stops. So that makes you, you know, ok maybe I should take my time, treat them well and then with that you realise these are actually cells.

American philosopher Milton Mayeroff gave one of the first philosophical accounts of care in his book *On Caring* (1971). Mayeroff defined caring as "helping the other grow" (1971: 1). Framing care around growth, growth became a way to assess whether caring had taken place (Mayeroff, 1971). As Grace articulated above, helping the other grow required being "sensitive" to its needs. Gilligan, a psychologist and prominent scholar of care theory and the ethics of care, writes that "caring requires paying attention, seeing, listening, responding with respect" (2011: 23). Each of these requires a sensitivity to the other that Grace spoke of. Grace's description grounds both of these definitions of care. Treating the cells right, respecting them, and honouring what they needed – so fundamental to caring – was vital for their growth. Caring was therefore absolutely necessary for the continuation of scientific research to avoid a situation where cells or bacteria did not grow, experiments did not happen and "research just stops"[34]. Taking time, as Grace said, made better science and better scientists.

Importantly, if caring is necessary for growth, then care is a vital necessity for life. Tronto, another prominent scholar of the ethics of care, argues that the definition of care may differ between societies and groups of people, but "*care is nonetheless a universal aspect of human life*" (1993: 110, emphasis added). Following Tronto's (1993) logic, life cannot exist without some form of care. Puig de la Bellacasa (2017), a leading contemporary voice on care, applies Tronto's (1993) assertion beyond humans. Puig de la Bellacasa argues that "for interdependent beings in more than human entanglements, there has to be some form of care going on somewhere in the substrate of their world for living to be possible" (2017: 5). There can be no growth, and therefore no life, without care. In the laboratory, growth and

[34] Ironically, we do not want *Mtb* to grow inside humans and animals. Biomedical scientific TB research aims to prevent TB from spreading and growing in the world beyond the laboratory. TB medication aims to stop the growth and spread of *Mtb* inside the human body. The TB "care cascade" is a staged model for eradicating TB through testing, diagnostics, therapeutics and healthcare delivery (see Naidoo et al., 2017; Agins et al., 2019; Subbaraman, Jhaverib & Nathavitharanac, 2020). In this model, care is precisely about preventing the growth of TB to save human lives. The contradictions of care – and the juxtaposition between the life of some and the death of others – are discussed further in this chapter.

living was possible because of the care by the scientists. The cells and bacteria needed to be cared for if they were to grow. At a most basic level, this involved feeding them media, ensuring they were "clean" by changing their media regularly, keeping them warm inside an incubator, and checking up on them (for some this meant "coming in on weekends"). This caring resembled caring for children. This was perhaps why some of the scientists referred to the bacteria, cells and other more than humans as their "babies"[35].

In 1980, Sarah Ruddick published an article titled "Maternal Thinking" (1980), which laid the philosophical foundation of thinking through care in the mother-child relationship. Ruddick's scope was the raising of children, and she writes, "For whatever reasons, mothers typically find it not only natural but compelling to protect and foster the growth of their children" (1980: 344). Ruddick (1980) continues the theoretical and practical relationship between care and growth that Mayeroff (1971) had started, but to this she adds the gendered dimension of care and the association of care with women, particularly in the raising of children. I began looking at this link to make sense of the relationship between my participants and their scientific subject-objects. My participants were enacting care theory and its situation in maternal relationships in a very real way. "These are our babies," Leigh said to me as she put a small freezer stock inside the laminar flow cabinet. She was referring to the bacteria inside a tiny amount of liquid in a small tube. Emily referred to the rhinos that she worked with as her babies. Speaking about the two rhinos that she "bled," she said to me, "These are my babies" [36]. There were bacteria babies, cell babies, rhino babies and (future) human babies in my research. It was not just the word "babies" that fascinated me, it was what a baby *requires*. Babies require care and carers to survive[37].

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[35] Alison and Marina never used the word "babies" to describe any of the living tools with which they worked, but they performed the same caring required to keep the bacteria alive. I am not framing *all* of the relationships as mother-child relationships, but rather as *caring* relationships. The mother-child relationship was what brought me to care in the first place because it was how the scientists in my first research project framed their relationship to the cells and bacteria (Shain, 2017). For the scientists who call their subject-objects their babies, I draw on these kinship metaphors. For the others, kinship becomes a thinking motif.

[36] Testing whether rhinos had TB involved Emily "bleeding" – taking blood samples from – the rhinos.

[37] Babies also require time, making further connections to the care time that was discussed in Chapter 1.

These requirements meant that scientists became carers, nurturers and mothers[38]. "I feel weirdly nurturing towards them, we want them to be happy, to be growing," Leigh said about the bacteria. Grace expressed similar sentiments, "You develop a motherly instinct when you work with cells." Elaborating, Grace said:

> It's like caring for babies. Making sure they are happy on a daily basis. Cells, when they are stressed, you can see… you always check on them every day, make sure they are happy… if they are not happy and you carry out experiments on them, you won't get accurate results.

Happy cells and bacteria meant accurate results. Since scientific research is dependent on accurate results, care is indispensable to scientific research. The happiness of cells and bacteria was strived for, and for them to be happy they needed to be cared for like a mother cares for her baby. There is striking similarity between Leigh's discussion of "happy" bacteria, Grace's discussion of "happy" cells and those of the laboratory technicians in Sarah Franklin's (2013) anthropological research inside a stem cell lab. "Keeping them happy" (Franklin, 2013: 81) was central to the work conducted by the stem cell laboratory technicians in Franklin's research. Further similarities are evident in Wakana Suzuki's anthropological research in a stem cell laboratory in Japan, which details "how scientists and laboratory technicians *care for* their cells and develop affective relations with them" (Suzuki, 2015: 89, original emphasis). These similarities show that the care for living tools in scientific laboratories so that they live and thrive as well as the affective and emotionally invested relationships that scientists have with these living tools, has relevance beyond the scope of this research project.

Care in the laboratory existed through practice – through the everyday tasks that were required to keep cells and bacteria alive and growing – and through ways of relating and sense-making that were translated through language, particularly through metaphors. Metaphors are important. Although the basic understanding is that metaphors describe something in terms of another (Lakoff & Johnson, 1980: 5), metaphors also "convey a deeper

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[38] In Chapter 4, I elaborate on and theorise the becoming-with and the relationships between my participants and the more than humans in scientific research. Charis Thompson's *Making Parents: The Ontological Choreography of Reproductive Technologies* (2005) would also provide an interesting layer to flesh out the idea of how parents are *made* within the space of the scientific laboratory.

level of comprehension of meaning and significance" (Mabeza, 2013: 131). Metaphors have further significance. George Lakoff and Mark Johnson (1980) argue that metaphors are part of our conceptual apparatus. This means that not only do metaphors guide a particular way of thinking, but a particular way of acting (Lakoff & Johnson, 1980: 34). Referring to cells and bacteria as babies not only highlighted their meaning and significance to the scientists who worked with them, but how they needed to be treated. In other words, the metaphor of the baby guided a certain kind of action since babies require care.

Grace spoke of how she had to "clean" the cells. She said, "like a baby that has poo'd, it does not want to be changed or cleaned, does not want to be exposed, but it has to." Grace checked on her cells every single day. While she looked at her cells under the microscope she said, "like babies can't speak for themselves, so you have to be observant, like how mothers do it." Held writes, "An ethic of care focuses on attentiveness, trust, responsiveness to need, narrative nuance, and cultivating caring relations" (2006: 546). My participants were building their own ethic of care through their interactions with the cells, bacteria and other more than humans as they cultivated their own caring relations. These relations were deeply maternal.

Most of my participants were emotionally invested in the happiness and growth of their babies. Grace said, "When I see my cells growing happily, I'm overjoyed." Ruddick writes, "When their children flourish, mothers have a sense of well-being" (1980: 344). This is specifically significant because scientists, like mothers, care for their "babies" and foster their growth. "On the other hand, no children flourish all of the time," Ruddick writes (1980: 344). There was great anguish when bacteria and cells were not growing (see also Suzuki, 2015: 100). I remember Grace's very sad face when she took out her culture flasks to begin an experiment only to find that the bacteria had not grown to her expectations. While I turn to the gendered analysis of care towards the second part of this chapter, it is important to first understand how some scholars have defined care. The following sections discuss some important concepts in care literature that speak to much of what I had observed in the laboratory. Caring *inside* the laboratory was the first of many layers of care in this research.

CARE AS *DOING*

Care has been defined as *doing* (Mayeroff, 1971; Noddings, 1984; Tronto, 1993; Ruddick, 1998). In other words, not just a thought, but an action, a practice, an activity, a labour, or an engagement. This is precisely what distinguishes care from concern. While to be concerned is to be worried or affected by something, to care is to be attached to something and committed to action (Puig de la Bellacasa, 2017: 42). The difference between care and concern lies in the difference between thought and action or *doing*. This is why, for Tronto, to care means to accept "some form of burden" (1993: 103). By accepting the burden, care becomes a "practice" that "involves both thought and action" that is oriented towards an outcome (Tronto, 1993: 108). For Ruddick, the goal of the "labour" or "activity" is the ability to "identify and meet the need of certain others" (1998: 10). Each of these definitions situate care within action or labour, removing care from the idealised realm of solely an attitude or virtue.

For Tronto, care has four "phases," namely, caring about, taking care of, care-giving and care-receiving. Each of these phases is based on action. *Caring about* points to the "need" for care and "that this need should be met" (Tronto, 1993: 106). *Taking care of* is about taking responsibility to respond to the need in the best way possible (ibid). *Care-giving* involves meeting the need through "physical work" and most often coming into contact with whatever or whoever is being cared for (Tronto, 1993: 107). Lastly, *care-receiving* involves the response to the care (Tronto, 1993: 107). This final phase of care shows that some form of action is required on part of the subject or object of care to fulfil the care relation (Noddings, 1984: 4). Scientific practice inside the laboratory involved each of these phases of care. Care was absolutely necessary for the cells and bacteria to grow. They could only grow if scientists assumed the responsibility of taking care of them and responded in the way that was needed for growth to happen. This required *care-giving*, the work of care that made up the mundane tasks in the laboratory, such as feeding the cells and bacteria with new media, keeping them warm inside incubators, cleaning them and responding appropriately should they not be "happy." Cells and bacteria responded to these elements of care by growing and flourishing[39].

[39] "Flourishing" is a central goal of ecological feminism according to Christine Cuomo (1998).

From the four phases of care, arise four ethical elements of care, namely, attentiveness, responsibility, competence and responsiveness (Tronto, 1993: 127-136). These four ethical elements of care push the analysis of care practice into thinking about caring relationships, such as caring as a relational practice between the one(s) caring and the one(s) being cared for. Ruddick highlights this aspect of care when she warns against over-identifying care with labour and stresses that "caring labor is intrinsically *relational*" (1998: 13-14, emphasis added). This moves the definition of care into the space of relationality and the cultivation of a particular kind of relationship.

RELATIONALITY, MUTUALITY AND DEPENDENCY

For Held, "An ethic of care focuses on… cultivating caring relations" (2006: 546). Care emerges as a relationship between the carer and the cared for. Relationality is about connections, connectedness and interconnectedness. Gilligan writes, "The ideal of care is thus an activity of relationship, of seeing and responding to need, taking care of the world by sustaining the web of connection so that no one is left alone" (1982: 62). The understanding of togetherness, of relationality, of the importance of relationships, is a cornerstone of care. Importantly, the caring relationship is rooted in interdependency (Gilligan, 2011: 23). Interdependency makes important knots with Donna Haraway's relational ontology (2008, 2016), M. Beth Dempster's concept of sympoiesis (1998), Lynn Margulis' holobiont (1991) and my discussion of the holarchy in the Introduction. Significantly for care, interdependency points towards how the caring relationship is mutually beneficial to both the carer and the cared for.

In his discussion on care, Mayeroff explains, "In caring for the other, in helping it grow, I actualize myself. The writer grows in caring for his [sic] ideas; the teacher grows in caring for his [sic] students; the parent grows in caring for his [sic] child" (1971: 21). This interdependent or *mutually* beneficial relationship between the carer(s) and the one(s) being cared for is what I define as mutuality. The concept of mutuality in relation to care dispels the myth that caring needs to be altruistic or selfless. As Held reminds us, "Persons in caring relations are acting for self-and-other-together" (2006: 540). In the case of this research, the flourishing of the cells and bacteria and scientific success (such as publications, outputs, careerism or self-preservation within scholarly competition) were not mutually exclusive. The caring was of

mutual benefit to both the carer and the cared-for, both the scientist and the scientific subject-objects. Since this was the case, mutuality involved dependency.

Noddings argues that both parties in the caring relationship are dependent upon each other (1984: 48). In the laboratory, cells and bacteria were dependent on the scientists to survive and thrive. The scientists were dependent on the growth of the cells and bacteria to conduct successful experiments and produce accurate scientific results. Although both scientist and subject-objects were dependent on each other for success, the scientists were in powerful positions in an utterly unequal dependency relation. But power is always asymmetrical in dependency relationships (Kittay, 1999: 34). This, however, does not mean that they are unethical (Puig de la Bellacasa, 2017: 156). My participants practiced ethicality in the face of unequal relationships, as I discuss in the next section.

It is important to note, however, that although power was asymmetrically distributed, the cells and bacteria in this scientific research were not powerless. They guided and produced scientific research as much as the scientists (see also Barad, 2012). Despret's (2004) concept of "availability," which I referred to in the Introduction as well as in Chapter 1, is an important characteristic of good scientific research. To reiterate, scientists who are available "give the opportunity to the 'subject' of the experiment to show what are the most interesting questions to address to him [sic]; what are the questions that make him/her the most articulate" (Despret, 2004: 124). These scientists are caretakers, interested in the possible becomings of their subject rather than scientists who are masters, requiring docility (ibid). For Despret (2004), availability is therefore opposed to docility. Availability is when "the animal is what articulates the system" and docility "is the system that articulates the animal, which just has to show how it obeys laws" (Despret, 2004: 124). As Alison said in the Introduction, good science was "not about okay I have a hypothesis, I must test it." For Alison, good science was about "let's try it and let's *observe* what happens." The difference is precisely the difference between availability and docility.

All of my participants were available to the possible becomings of the cells, the bacteria and the samples. In fact, it was these experimental subject-objects that would often lead the way and guide the outcome of the experiment. Samples would show themselves as either

Mycobacterium tuberculosis, *Mycobacterium bovis* or something else; they were either positive or negative. In the case of Grace's research, the cell and its protein needed to *show her* what they did in an attempt to rid the cell of *Mtb.* Marina's work on persisters was about understanding them, and therefore, allowing them to articulate the system. This was even more obvious in the project that Leigh was conducting alongside her postdoc research. Using a confocal microscope, she found something very unique and interesting about the bacteria. She said to me excitedly, "you're meeting a scientist at an exciting point in her career" since her project was "working" and "everything is coming together" which, I was told, was "rare" in science. This shows that scientists do not have control over outcomes, things working are "rare." Leigh needed to remain available to possible becomings, to what the bacteria had to show. Here, the bacteria were articulating, rather than being docile subjects of human mastery. But it cannot be ignored that although scientists were available and cells and bacteria articulated systems in multiple ways, the subject-objects were disposable, reproducible and in the scientists' care. Having said this, it is interesting to note that my participants did not measure success in the same ways that science measures success, such as publications, outputs and visibility in the academy. They had different ideas about what it meant to be a "good scientist." This complicates any simple critique that their goal was scientific results at the expense of the lives of the living tools with which they worked. I elaborate on this in Chapter 5. This discussion has highlighted some of the contradictions of care in science with more than humans, which is expanded in the next section.

CARE, KILLING, VIOLENCE AND PAIN: RECLAIMING CARE FROM IDEALISED MEANINGS

Like the bacteria that need to be "rescued" from freezer stocks, care needs to be rescued from "idealized meanings" (Puig de la Bellacasa, 2017: 8). Care can be exploitative, controlling, discriminatory, unbeneficial, instrumental and violent. Tronto reminds us that "care involves conflict" (1993: 109). In this research, this side of care might lead to questions such as: Do the scientists actually care? What do they care about? Can asymmetrical power relations really be defined through care? Can caring and killing exist side by side? How can multiple and conflicting cares be reconciled? Importantly, do these contradictions arise in the laboratory or in the theorising? In other words, are the questions scientist questions or social scientist questions? Do I, as a researcher – in light of the contradictions – need to justify the

care relations I observed as ones of care? Care is ripe with contradictions. I have not come across a single scholar of care who ignores this. The politics of care, rich with "predicaments" (Puig de la Bellacasa, 2017: 164), are built into understandings of care in the literature.

If care, in theory, is complex and troubled then theorising care from ethnography is even messier. Puig de la Bellacasa argues that "ethnographies of care" cannot be removed from their "messy worldliness" (2017:10). There is no neat way to speak about the contradictions that occurred in the laboratory. Most often, bacteria, cells and mice were killed at the end of experiments. But just as often, bacteria, cells and mice were cared for so that they would be happy and grow. Inside the laboratory, caring, nurturing, exploitation, control, and killing existed side by side. Sometimes in the space of a single encounter. I saw millions of bacteria being killed, but I also saw millions that were kept alive inside freezer stocks, waiting to be cultured up again and "rescued," in the words of one of my participants. The only way to grapple with this messiness is to show it through ethnography. It is to the messy worldliness that I now turn.

One day Leigh was extracting proteins from *Mtb* culture flasks inside the BSL3 and said that she wanted me to understand the "hard science." She spoke about the "Scout Hypothesis" whereby dormant cells "wake up" arbitrarily and become active again (Buerger et al., 2012: 3221). In TB, these dormant cells are known as "persisters." In order to see whether the patients in her study had persisters, she needed to stimulate potential dormant bacteria in the sputum to "wake up." After this process, if the culture was positive for *Mtb*, Leigh could confirm that the patient still had TB and was likely to relapse.

To stimulate the dormant bacteria to "wake up," Leigh needed to add Resuscitation-promoting factors (Rpfs). Rpfs target the cell wall and wakes them up. Rpfs are proteins that *Mtb* produces at a certain stage in its growth. *Mtb* releases them into the environment when they are happy. Leigh explained that by releasing the protein, they were "communicating" to other bacteria that the environment was good so that they could "wake up" and start growing. Leigh described the process of getting Rpfs as "harvesting" and "exploiting" the bacteria. Scientists know the exact time in the growth stage that the bacteria release this protein, and so they are able to "extract" it from the bacteria's environment to be used. After

the protein has been extracted, the bacteria that produced the protein are killed. Leigh said sarcastically to the bacteria about to be killed, “Thanks for producing protein. Now die.” This happened just after she spoke with admiration about what a “clever pathogen” *Mtb* was and how it had evolved. “It doesn’t act like other bacteria,” Leigh commented, then she looked at me with wide eyes and asked, “Did you know that TB is the only bacteria that doesn’t have sex?”

On another day, I was watching a part of Leigh’s method. At one stage, the bacteria that were not put into the new culture flask to grow needed to be disposed of. “You're party to murder,” Leigh said to me as she killed the bacteria by adding Distel to the flask. Distel is a potent disinfectant that is used to clean contaminated surfaces and equipment. Its active ingredients kill by penetrating the cell walls of bacteria, viruses and fungi. Leigh gently turned the flask around so the blue liquid washed over the surface area of the flask. She said that when she did this, she imagined the bacteria screaming as the Distel broke open their membranes and killed them. Moments later, Leigh put a ten-year-old freezer stock of bacteria into a small flask and said to it, “grow babies, grow.” This freezer stock of bacteria was one of two strains of *Mtb* that she was “rescuing.” These were freezer stocks of H37RV and Erdman strains that had been “passaged” through mice. Leigh wanted to use these to infect the baby mice – which she referred to as “pups” or “pinkies” – rather than the lab strains she was culturing because lab strains were “not that virulent.” “You don’t want to infect the mice with bacteria that are less virulent, otherwise it’s a bit of a waste,” Leigh explained.

Leigh explained further that the environment of the laboratory was “very favourable,” meaning the bacteria had “quite an easy life in the lab which makes them less virulent.” She told me to think about what the bacteria experience inside the bodies of humans and animals, where the immune system really makes them “work to survive.” This is why a bacteria strain that has experienced the harsh environment of the body (human or animal) is more virulent. “To get these strains,” Leigh explained, “you need lab strains that have been put into an animal.” These strains “regain their virulence and then they're taken from that animal.” To get these strains, the animal needs to be “sacrificed.” This means cutting it open, and taking parts of its body – particularly the lungs – to culture the bacteria. This was what Leigh was referring to when she said that the bacteria had been “passaged” through mice. When Leigh

put the Erdman stock into the small starter culture flask, she said that it was "a very virulent strain": "more infectious," "more pathogenic," "it's been primed to infect." "*This bacteria wants to infect something*," she said looking at the flask.

Leigh explained that it was difficult to grow old stocks, "but the good thing is that TB doesn't die," as they are "very strong and resilient." Leigh spoke about a colleague who "literally just put the bacteria in PBS [Phosphate-buffered saline], which has no nutrients, and froze them and they still grew." The reason why TB bacteria die when they are frozen is because "the ice crystals pierce their bacterial bodies." Scientists put glycerol inside the aliquots (small tubes) to prevent the ice crystals from doing this and to "protect" the bacteria. Leigh explained that when the freezer stocks are taken out of the freezer, "you need to let them thaw slowly. You don't want to rub them in your hands as a lot of people do because then it shocks the bacteria and you don't want to shock them." Leigh would leave the stocks to thaw inside the hood while she did other things, and once they had thawed, she would add them to media inside small flasks. "You can't just put them into a big flask," she said, "otherwise they won't grow." They need "a small volume at first and to be close to each other." When Leigh carried out this process for the strains that she would use to infect the "pups," she said that she really hoped they grew. Once these bacteria had grown to her satisfaction, they would be used for infection.

Towards the end of my fieldwork, the division was starting an animal laboratory. As Grace explained, the lab represented "science going forward, because after working on the cellular model, you want to go into the animal model." Scientific research with mice was the next step in scientific TB research. At the time of my fieldwork, Leigh was one of the scientists heading the new animal lab because of her training and experience working with mice in a laboratory overseas. Four female and two male "BALB/c" mice had been purchased from another university in South Africa to start the animal lab[40]. The males were used for reproduction and were killed after they had fulfilled their reproductive purpose, while the female mice were

[40] The BALB/c mice were apparently known as "the surfer dudes" of the laboratory mice species because they were "more chilled," Leigh explained. She said that when working with the mice she would sometimes ask them, "are you okay?" because they "did not budge."

used in experiments. Leigh explained that this had to do with the dynamics of the mice. Males needed to be kept separately because otherwise they would fight with other males, but mice cannot be alone because they get "lonely." Since females *can* be kept together, they were the best option. Furthermore, female mice were "more docile" and "less aggressive" compared to the males, making them better experimental subject-objects, I was told.

The mice were given "the best environment possible." Leigh explained that there was "a high standard of care" inside animal laboratories. Elaborating, she said that the mice were given "everything possible to make their lives better" including "toys and stimulation." This treatment was more than what could be said "for pet stores where they are bred for snake feeding or to be pets," Leigh explained. In the laboratory, the mice were checked on four times a day *every day*, including weekends. In the overseas laboratory in which Leigh had worked, part of being hired involved a process whereby the scientist was observed handling the mice. If they did not uphold the standard of care, they would not be allowed to work in the laboratory. During my fieldwork, Leigh was on the committee who decided which research on the mice could go ahead. She was happy about this because she could ensure that only the projects that were very promising and "absolutely necessary" would be accepted. She was also going to be training whoever would be working with the mice, which gave her the authority to stop scientists from working with them if they were not handling the mice "well."

The fate of the mice was their death by the scientists. Leigh thought deeply about how the mice would be killed. In the overseas laboratory at which she worked, the mice were put in a carbon dioxide tank. "When the mice breathe in the carbon dioxide, they asphyxiate and die in ten seconds." Leigh explained that this method was favoured because it was "quick." She, however, did not like it because although it was only ten seconds, it was a "traumatic death" for the mice since they "squirm around in the tank." For Leigh, the more "bearable" method of killing was to anesthetise the mice and then once unconscious, break their necks. Although this was "not ideal," Leigh said, "no death is ideal."

I joined Leigh in the BSL3 one afternoon while she prepared the bacteria that would be used to infect the "pups." The four female mice were pregnant at this stage. Since the animal

laboratory was just starting up, a pilot test needed to be conducted to ensure that everything worked. Between six and eight weeks after birth, thirty pups would be infected with *Mtb* and ten would be used as a control. Leigh said that she did not like that the pups had not even been born and their fate was already decided. “I can kill millions of bacteria, but not mice,” she said. Each pup would be put inside a tank-like system that was designed so that the mouse would inhale a certain number of bacteria that were aerosolised and put through a pipe. For the pilot, ten bacteria would be put through the tank. The mouse would then be infected with *Mtb*. When I asked Leigh during our interview how the mice were doing, she responded warmly, “The pups? They’re doing good, yeah! They’re growing. They’ve got hair now. They’ve all opened their eyes. They’re very cute.”

I use Leigh’s research here to flesh out the care contradictions that I observed in scientific research, but these contradictions were by no means limited to her work alone. Contradictions were ripe throughout and surfaced within the scientific research and interests of each of my participants. Bacteria were exploited, bacteria were rescued, bacterial proteins were harvested and extracted, bacteria were woken up, bacteria were given space to live, bacteria were cared for, bacteria were killed by the millions, bacteria were called babies, bacteria were clever, bacteria were admired, bacteria were nurtured, bacteria were strong and resilient, bacteria were dangerous, bacteria had easy lives in the lab, bacteria were virulent, bacteria were protected, bacteria were primed to infect, bacteria murdered and were murdered, bacteria were treated carefully so as not to shock them, bacteria were given favourable environments, bacteria and cells were disposable and reproducible. Cells were infected with *Mtb,* cells were killed, cells were fed, cells were broken open, cells were kept nice and warm inside incubators, cells were harvested and exploited. Mice were cut open, mice were called pups, mice were used for reproduction, mice were cute, mice were infected with virulent *Mtb* strains, mice were kept together so they would not get lonely, mice were killed, mice were given the best environment possible, mice were anaesthetised, mice were given toys and stimulation, mice were cared for, mice were sacrificed, mice were checked on regularly and on weekends. There is no easy way to write about this. The lives and deaths of bacteria, cells, mice, rhinos, lions and humans were tightly woven. The life of some would lead to the death of others and the death of some would lead to the life of others. Again and again, on most days inside the BSL3.

KILLING AND VIOLENCE IN CARE LITERATURE

The literature on care does not shy away from discussions of killing. Noddings writes, "To remain one-caring, I might have to kill" (1984: 102). Puig de la Bellacasa explains, "In some contexts, care is inseparable from killing: like in weeding one's garden to make possible more fertile growth… Sometimes the question of how to care might mean that we have to engage with issues concerning if, why, and how to kill and for what" (2017: 164). When killing has to be done in care relationships, thinking through *how* to kill is important. Leigh's decision about *how* to kill mice was exactly that. Ruddick explains, "There are many stories of mothers who, with resourcefulness and restraint, help their children to die well" (1980: 351). Leigh helped the mice die *well*, in a manner that was more *bearable* for them. The *why* and *for what* that Puig de la Bellacasa (2017) raises above is paramount. Nodding's describes this ethical dilemma of justification, as if speaking to the research that I had observed:

> Can the infliction of pain be justified? The one-caring cannot, logically, argue that there is no such justification. Her ethic springs from human caring. She might insist that animals be spared pain whenever possible, but if animal pain is inescapable in the investigation of ways to relieve human suffering, she must logically accept this. Still, she would ask: Is there some other way? She does not brush aside lightly what she is doing in, say, vivisection. She looks at herself: I am one inflicting pain upon this creature in order to reduce pain in these creatures. I am doing this. Must I? If there is another way, if, for example, that which she may learn is already known by others, she will turn to these other sources (1984: 159).

Noddings (1984) captures beautifully the relationship between care, pain, violence and killing in a scientific laboratory. She touches on the complexities of pain, suffering and justification in the face of human suffering. Through these words, Noddings connects the hood to the world outside and shows the questioning and careful thinking that occurs alongside the enactment of protocols. As I have shown through Leigh, there is a lot of careful thinking in scientific practice. Grace also thought carefully about animal research.

On our way to the tissue culture lab one morning to check on her cells, Grace told me about something she had heard some other scientists saying about the "sacrificing" of mice in

research. What stood out for her was that they said that whatever was left of the animal "ends up in a tube." Reflecting on this, Grace said, "like it's a life, it's a being." She expanded on this in an interview, saying, "you grow up these animals, you feed them and then you do your experiments with them and at the end of the day you sacrifice them and homogenise their tissue at the end of a tube." Grace was grappling with this tension when she thought about working with mice and having to sacrifice them. The distinction between sacrifice and killing in Grace's response below touches the heart of justification that Noddings (1984) highlighted above:

> Yeah, and I have a friend that was explaining to somebody that she sacrifices her animal... And then the person was like "no you don't *sacrifice* them, you *kill* them." And then she was like, "no I *sacrifice* them, they are *sacrificing* their life for science." And the person was like "no, you *kill* them, you *kill* them." So that also made me appreciate the animals because they are also sacrificing their life for science. They are helping us. They are helping us understand TB better... They are sacrificing their life. It's not like they really had a choice. The choice was in our hands. But they also playing a part in being there.

"Sacrifice" points towards a greater purpose, whereas "killing" denotes death without meaning, unjustifiable cruelty even. That death in the lab was justified did not, however, make it any easier. As I showed in the previous section, Leigh had found it very difficult to kill the mice. For Grace, there was worry that she would not be able to treat the animals *well* and that she would get emotionally invested to the point where she would not be able to kill:

> It's quite interesting because I'm a bit sensitive. Like now I'm getting to living creatures, cells are also living, but now it's like an entire organism. I'm not sure if I can handle the emotional aspect of infecting animals, sacrificing it. I don't think I'm there yet. I don't think I can do it… I would like to be involved in that process of working with an animal that would eventually, like follow through the entire process and see how the results made an impact. I guess I will probably grow into it, but now, I don't know… So, I didn't grow up with animals, I'm not so attached to animals. I don't know how I'm, I'm hesitant to, like I don't want to hurt them, or do something wrong, so I just stay away. So that's the thing. If I'm now going to sacrifice the animal at the end of the day… like I'll probably grow into it.

Grace opened up about her hesitancy because she did not want to hurt the animals or do something wrong. She would need to "grow into it," weaving significant links to my discussion on growth and the idea that caring is helping the other grow and growth is fundamental to care. Grace would need to grow into care, showing her deep understanding of this theoretical connection. She would also need to grow into killing. Care is complex and troubled. The justification of killing in the science that I observed seemed to be the "impact" – the eventual development of ways to prevent TB from killing humans and animals such as rhinos and lions. As the ethnography shows, there was care in the very interrogation of what it meant to kill. The tension between care and killing cannot be resolved. But my participants gave this tension the care of interrogation, and did not merely dismiss it as part of their job. Killing occurred, specifically the killing of living tools they were attached to, but there was tremendous thought about it. These thoughts and conversations were indeed happening. Scientists were not robotically carrying out scientific protocols or killings. They were thinking, reflecting, conversing. They cared. But was this just because they were women?

FROM MATTERS OF GENDER TO MATTERS OF CARE

The concept of care is deeply gendered. I discussed this in Chapter 1 using the timescapes of women's careers. In the literature, the connection between care and women was made explicit in Ruddick's (1980) situation of care within the mother-child relationship. This link between care and women was then explored in the foundational and influential work of Gilligan beginning with her book *In a Different Voice* (1982) and later with her response, *Joining the Resistance* (2011). Gilligan's work inspired a huge body of literature on the ethics of care by scholars such as Noddings (1984), Baier (1987), Kittay and Meyers (1987), Ruddick (1987, 1998), Tronto (1993), Held (1995, 2000, 2001, 2002, 2004, 2006), Kittay (1999) and Slote (2007), to cite a few.

In *Joining the Resistance* (2011), Gilligan explains how her research emerged. In the early 1970s, she worked as a research assistant for psychologist Lawrence Kohlberg. Kohlberg was theorising moral development, but used only men in his research study. The result was that moral reasoning – the ability to make a judgement and take appropriate action in the context of a moral conflict (Gilligan, 1982:1) – was generalised from the male point of view. Therefore,

not only were "men were the measure of humanity," but "*autonomy and rationality ('masculine' qualities) were the markers of maturity*" (Gilligan, 2011: 16, emphasis added). Kohlberg developed a hierarchy of moral reasoning, a staged system that would lead to *justice* – the ultimate moral judgement and action. In this system, women only made it to the third stage. They were deemed morally inferior because their judgements and actions in moral conflicts did not meet the criteria of morality.

The disparity between psychological theories on moral development and the "different voice" (Gilligan, 1982) of women led Gilligan to pursue her own research on morality with women. When moral theory was developed from the perspective of women, what mattered changed. The women's moral judgements in Gilligan's study were directly opposed to the men's moral judgements in Kohlberg's study. They were based on relationships rather than the individual; connection rather than separation; emotional responsiveness rather than rationality or objectivity; responsibility and relationships rather than rights and rules; and they were contextual and nuanced rather than speculative and impersonal (Gilligan, 1982: 19). While men asked, "What is just?" in a moral conflict, women asked "How to respond?" (Gilligan, 1982: 35). The difference is precisely the difference between connection and detachment. Noddings echoed this when she described the ethics of care as a feminine view of morality "rooted in receptivity, relatedness, and responsiveness" (1984: 2) compared to the masculine view framed by law, principle and detachment. Two distinct moral perspectives developed across gendered lines, namely, the masculine moral theory of justice and the feminine moral theory that became known as "the ethics of care." The ethics of care became a feminine and feminist ethics because without the inclusion of women in the research on moral reasoning, moral theory would be devoid of care (Gilligan, 1987: 38).

In reading the theory of care and its development in the literature, I noticed parallels between the pillars of justice and the pillars of science. Both justice – as it was conceptualised by Kohlberg – and science share common defining features. Some of these include law, principle, objectivity, detachment, reason, logic, rationality, mind and self. Put simply, justice is comprised of all the characteristics of "rational man" (Gilligan, 2011: 23), and the scientist is the ultimate "rational man." Science was founded on the principles of logic and rationality, separating itself from the beliefs and superstitions that were characteristic of religion

(Sarukkai, 2012: 52). But what is logic? Logic opposes the knowledge that is gained through the sensory organs in favour of knowledge that is gained "through a capacity of the mind alone" (Sarukkai, 2012: 55 & 56). I address this in detail in Chapter 3. What is important for now is the understanding that obtaining logical knowledge requires a *separation* of observer from observed, a *detachment* so that the knowledge is *objective*, which just means it is *logical* or *rational* or *reasonable.* It favours the *mind* rather than the body and the *self* rather than relationships since one must remain as *detached* as possible to obtain *objective* results. The moral theory of justice and the founding principles of science strongly resemble one another.

But this did not resemble what I heard from my participants nor what I observed in the laboratory. Relationality, responsiveness, response-ability, receptivity, connection and emotion were central to the interaction between my participants and the living tools with which they worked. In Chapters 4 and 5, I argue that these qualities extended beyond the laboratory as well. Where science is generally thought to be associated with reason, mind and self; the science that I had observed was rooted in emotion, body and relationships. I discuss the body at length in Chapter 3. These observations made me think more about the significance of care in relation to science. Puig de la Bellacasa (2017) had already begun making these connections.

Puig de la Bellacasa (2017) developed the concept "Matters of Care" to evolve Bruno Latour's (2004) "Matters of Concern." Latour developed matters of concern to show how scientific *facts* (presented simply as "matters of fact") are produced by particular *concerns* (2004). I worked through the influence of my own concerns in Chapter 1. Put simply, Latour's (2004) aim was to re-insert the social into the natural and the subjective into the objective. Or, in other words, to render visible the (subjective) human behind (objective) scientific research. Puig de la Bellacasa (2017) developed matters of care because, according to her, Latour did not go far enough:

> Representing things as matters of concern was a response to a bifurcation of nature, a splitting of meanings and matter, the social and the natural in the life of things. In a way, matters of care respond to a related "bifurcation of consciousness" (Smith, 1987): *The*

splitting of affective involvements from the researcher's experience (2017: 62, emphasis added).

Matters of care aims to reveal the care and affection that exists behind scientific matters of fact by allowing space for them in the narratives of science. It did not take long after being in a laboratory to observe that affect and care had made their way into the experiment, and beyond it.

Leigh said in an interview that "it's very hard not to get emotionally involved. I find if a scientist says they're not invested emotionally in their project they're probably lying. You have to be." Woven throughout this thesis are ethnographic examples of how affect made its way into the laboratory and beyond. This had *nothing* to do with experimental bias or tampering with the objectivity of an experiment. As Hubbard notes, "science imposes a hegemony within which all its practitioners must operate if they want what they do to be acknowledged as science" (2003: 791). This had *everything* to do with the inescapable fact that subjective experience can never be separated from fact, that matter has meaning, that the natural and the social are not mutually exclusive, and that science is produced by people. People feel, they have emotions, they experience the world, they care. Justin Dixon writes about the unexpected care that he observed "in the middle of what was effectively a bio-scientific experiment" (2012:43). As if speaking directly to the concept of matters of care, Dixon writes, "A particular irony of the clinical trials industry is that, the more a researcher aims to accumulate data in the interests of such paradigmatic scientific values as reliability, validity and that most notorious one, objectivity, the more subjectivity the researcher encounters" (2012: 47). For some reason, the subjectivity, the touchy-feely stuff, the fluff, does not make its way into our imaginings of scientific worlds.

Matters of care, and care itself, is not unique to women. It is important to flag that *I am not arguing that only women scientists care*. The scope of my research within the realm of women scientists was practical – they dominated the laboratory space in which I conducted fieldwork. And although care theory and the care in ordinary life is gendered in particular ways, this does not mean that men do not care. When I attended the closing plenary session of the 5th South African TB Conference in 2018, Professor Andreas Diacon – a highly esteemed male scientist

in the field of TB science – made a comment during his presentation that highlighted the relationship between scientists and *Mtb* in the lab. Diacon said, "In the laboratory we make them happy, we give them a bit of music, and 37 degrees, and sugar and proteins, all the things they like." This comment encompasses the relationality, responsiveness, attentiveness, receptivity, response-ability and connection that is so characteristic of the ethics of care. It also shows the kind of personal and subjective that was the reason for Puig de la Bellacasa's (2017) matters of care. In the literature, examples from male scientists abound.

Henry Wallace – a renowned plant breeder, the 11th Secretary of Agriculture to the United States as well as a former U.S. Vice President – said that it was "Sympathy with the plant" (Culver & Hyde, 2000: 518 in Hubbard, 2003: 796) that was the reason for his success. Zoologist Michael Hadfield writes to Haraway (2008) about the snails he works with: "I also find the snails to be beautiful and their babies to be 'cute', but that's not very scientific, is it?" (in Haraway, 2008: 91)[41]. This example raises an important question: what is scientific? Sympathy with plants, "feeling" for organisms (in the case of Barbara McClintock[42]) and caring for cell and bacteria babies all point towards *a different voice* of science. It is different because it is a *human* (subjective) voice, not because it is a *feminine* voice. This voice inserts the lifeworld of the scientist into the purified science. To some, this voice runs counter to the "seriousness" of science and that is why it is a delicate matter. Anything delicate needs to be handled with care.

When Professor Diacon spoke about "happy bacteria" in the laboratory, his statement was met with laughter. As I sat there in the massive auditorium, with scientists laughing all around me, I thought about the laughter. I recalled hundreds of similar statements made by my participants throughout my research. I also recalled similar amusement in the general reactions to my interest in care and science and focus on bacteria as "babies" that needed to be "cared for." Interrogating these reactions sheds light on what it means to think and write about care in the context of science. Puig de la Bellacasa asks, "Is care too touchy-feely for

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[41] The laboratory technicians in Suzuki's research referred to their cells as "*kawaii* [cute]" and for the senior laboratory technician, only scientists who "feel that cells are *kawaii*" are hired (Suzuki, 2015: 95).
[42] "A feeling for the organism" was a phrase of scientist Barbara McClintock, which Evelyn Fox Keller used as the title of the biography she wrote of McClintock (1983 in Hubbard, 2003: 796).

the imaginary of technoscientific networks? Is it too suspicious of a naturalization of feeling that seems to contradict the naturecultural entanglements of technoscience?" (2017: 62). The sanitising and "purifications" of scientific matters of fact as "matters of fact" produce "silences" that render invisible "embarrassing affections ridiculed in scholarly contexts" (ibid). Susan Leigh Star referred to this as the "Transcendental Wall of Shame" (2007 in Puig de la Bellacasa, 2017: 62). Matters of care intervenes, exposing what is cared for, and therefore revealing the human behind matters of fact. Sometimes that may be embarrassing, but these narratives exist in scientific research even though they do not seem to make their way into the archive of our imaginings of scientific worlds. This research creates a space for the matters of care that always exist behind scientific matters of fact.

Using the framework of care as an analytical tool does not mean that the science that my participants conducted was any less excellent. By representing the world of technoscience as matters of care, by showing the care, the affective engagements and relationalities that exist in scientific research, there is a disruption of the kind of longstanding views of technoscientific worlds. This is part of what the theoretical lens of care achieves in a discussion of science. The point is to get away from purifying or sanitising or "matter of facting" the analysis to reimagine and re-engage with the personal in the scientific, the subjective in the objective, and the emotion in the production of scientific research and results.

This is about thinking with care, and Puig de la Bellacasa reminds us that we cannot *not* think with care because care is always present in some way, in some form, at some time (2017). Puig de la Bellacasa argues that "dismissing the work of care contributes to building disengaged versions of reality that mask the "mediations" that sustain and connect our worlds, our doings, our knowings" (2017: 87). The reality of science that I observed and that I portray in this thesis is engaged, revealing the affectionate mediations that sustain and connect the world of science, and the doings and knowings of the scientists in this world. This is precisely matters of care. It is a lively world of passionate science that takes Despret seriously when she writes that:

> To 'depassion' knowledge does not give us a more objective world, it just gives us a world 'without us'; and therefore, without 'them' – lines are traced so fast. And as long as this

> world appears as a world 'we don't care for', it also becomes an impoverished world, a world of minds without bodies, of bodies without minds, bodies without hearts, expectations, interests, a world of enthusiastic automata observing strange and mute creatures; in other words, a poorly articulated (and poorly articulating) world (2004: 131).

De-passioned knowledge is matters of fact, it is the disengaged version of reality and knowing. Michael Polanyi (1966) wrote about this decades before in his conception of "Personal Knowledge," which I discuss at length in Chapter 3. He wrote, "An attempt to de-personalise our knowledge of living beings would result, if strictly pursued, in an *alienation* that would render all observations on living things meaningless" (Polanyi, 1966: 14, emphasis added). I have been arguing throughout this chapter that care and an ethics of care is about connection rather than alienation. If *not caring*, as Despret (2004) insinuates, is about separating minds, bodies and hearts, then caring is about connecting the mind, body and heart. Matters of care responds to this, pushing for the recognition of affection and emotion (the heart) in the creation of knowledge, or what Puig de la Bellacasa has called "affectionate knowing" (2017: 62). In the next chapter, I discuss the centrality of the body in the creation of knowledge so that by the end of this thesis, mind, body and heart are woven together in a narrative of science. In the spirit of convivial scholarship (Nyamnjoh, 2017), this extends the thinking of Hilary Rose's "Hand, Brain and Heart" (1983), but also pushes the discussion into decolonising science.

It was in this lively and passionate world, rich with multispecies relations and caring engagements, that I made links to the decolonising project. It was in the bodies, hearts, minds, expectations, interests and enthusiasm of scientists vibrantly articulating their worlds that I saw the potential of care as a tool for decolonisation. But how could something as unsuspecting as care be such a tool? As Tronto notes, since care is associated with the private (often domestic), the emotional and the inconsequential, it is hard to see that care can have "broader social, moral, and political ramifications" (1993: 112). Care does indeed have broader potential that is underestimated because of its associations. It is care's disruptive nature that makes it powerfully transformative. In this way, care has a part to play in thinking about ways to decolonise science. But first, the ability of care to disrupt must be understood.

CONTAINING CARE: CARE AS DISRUPTIVE

Puig de la Bellacasa wrote that care is "a critically disruptive doing" (2017: 12). I came to fully understand this through Tronto (1993), who views care as a powerful political instrument of change. Tronto (1993) puts forward a political theory of care to imagine what a world that prioritised an ethics of care would look like. This world would recast itself from one that is founded on autonomy to one that nurtures interdependency (Tronto, 1993: 101). Care, therefore, disrupts what is currently valued, specifically how that has led to our current geological era known as the Anthropocene and, more recently, the Capitalocene (see Haraway, 2016; Moore, 2016; Grusin, 2017). Tronto's (1993) argument for care as a political instrument of change that she put forward almost three decades ago is of equal relevance today. Gilligan wrote, almost thirty years after *In a Different Voice* (1982), "If anything, an ethic of care is more pressing now than at the time I first wrote about it… We live in a world increasingly alert to the reality of interdependence and the costs of isolation; we know that autonomy is an illusion – that people's lives are interconnected" (2011: 17-18). We are at a point in human history where not understanding human, more than human, and planetary entanglement will have devastating consequences. This brings Achille Mbembe's (2015, 2019) concepts of "deep time" and "deep history" to the foreground. We have to understand our position as humans *in relation* to everything else on this planet – living and otherwise. Our pasts, presents and futures are thickly woven together whether we like it or not.

Care centres interdependence, connectedness and relationships. A world that prioritises an ethics of care would be a world that accepts that we are interdependent. The consequences of understanding that we are interdependent mean that we are called to take responsibility. Held writes that the ethics of care "often calls on us to take responsibility, while liberal individualist morality focuses on how we should leave each other alone" (2006: 543). Responsibility, a central element of care which I have shown in the previous sections, requires action. This is particularly important at a time when ignoring our interdependence is putting us – humans and more than humans – at risk (Gilligan, 2011: 177). Therefore, discussions about care are also discussions that highlight its absence. Centring care reveals where there is lack of care, carelessness.

It is for this reason that "In its more developed forms, the ethics of care as a feminist ethic offers suggestions for the radical transformation of society" (Held, 2006: 541). This is what I argue through my research with my participants, and so I substitute *society* with *science*, though never ignoring the very real implications and disruptions an ethics of care can have for the transformation of the society in which we live. Especially because an ethics of care paves the way for multispecies thinking, expanding what is meant by society. Interestingly, *society* comes from the Latin word *socius*, which means *companion*. Haraway's "companion species" (2008) is brought into sharp focus again, highlighting the unequivocally relational and interdependent – sympoietic – reality of our world. A developed ethics of care really does transform society in its expanded definition of the social beyond humans. But for science, thinking through the potential of care for decolonisation calls into question how far scientists and science's caring extends. It was, in fact, in a presentation that I gave in 2018 at the City of Cape Town TB Clinical Forum at Stellenbosch University on how multispecies caring inside laboratories taught me about care in science, that the question of whether scientists actually care and what they care about became a topic that attracted a lot of discussion in the room.

DO SCIENTISTS ACTUALLY CARE?

I invited the scientists from the division as well as the heads of the division to attend the presentation I was giving on the social markers of TB and my research on care in science. I thought that it would be a good way for them to engage with my research. At the end of my presentation, I opened the floor for commentary. Alison, who was an audience member, argued that although scientists may care about what they are doing inside the laboratory, and for their bacteria, they do not care much beyond it. Her perspective adds another layer to the contradictions surrounding care, and care in science. In our interview, I asked her to elaborate:

> So, I grow up *Mtb* and then I infect macrophages, but my concern is never about the bacteria. I don't care, I mean I care for my experiment to go well and I think that you have to give it certain nutrients because that's what it requires in order for the experiment to succeed. But I've never cared about the bacteria because for me, even though it's an organism, it does not have emotion. There's no significance attached to that organism. I

care for the larger animals because that has an implication for other living animals and because, so even though those animals that we get tissue from are dead, whether or not they are positive and what bacteria they are positive with or infected by, that has an implication for other animals. And lions are threatened so that sort of pushes up my care. So, I can't, I don't know. I think it's different personalities also that maybe attribute care to certain things. Because it's funny cause I could deduce who you were speaking about when you spoke about the care for the bacteria. And especially there was one male that you had interviewed and it was funny because in our environment they don't express care towards others. But I guess a lot of scientists do that, where they are withdrawn socially from certain places, but then those emotions that they cannot show others, they can't express those emotions socially, so they then find another outlet for those emotions, which is what they do with the bacteria. Yeah, but I mean I can't speak to that specific issue.

It took me a very long time to reconcile what Alison was saying. Her words brought me to interrogate whether scientists cared about the bacteria at all, not to mention cared in general. I started to think about what I called "hierarchies of care," a model that follows a hierarchical structure of importance with bacteria at the bottom, animals somewhere in the middle and human beings at the top. As Tronto (1993) and Puig de la Bellacasa (2017) have shown, care is vital to life. Care *had to* exist for the bacteria to survive, so I began to think about what Alison was saying in terms of *how much* care was given to the bacteria in relation to larger animals. I asked Leigh what she thought about "hierarchies of care." I broadly defined it as the ways in which care seems to increase as the organism becomes bigger or more "significant" – following Alison's line of thought – with the human being seeming to be given the most care. Leigh responded:

I don't know, I hadn't been exposed to human research before when I was working on abalone, but I feel like I take the same care with my abalone samples that I did with human ones. But there is the thing in the back of your mind with abalone, if my experiment goes wrong, I can go and infect more abalone and I can bleed more. You cannot do that with clinical human samples. You cannot. What you get is it. So that is always in the back of my mind, like I cannot mess this up because it has to be done properly. This patient isn't coming back or this patient really needs to know what's

> happening here. So, I think there is probably a level of hierarchy. Yeah, bacteria you can grow them up again, you can just make more and more and more, so your experiment can be repeated. It's not the same for clinical research. Human research is definitely, for me, like the pinnacle of your utmost care. But I think you should feel that way about all your experiments, obviously.

Hierarchies of care did not seem to fit. Leigh stressed that she treated all of her samples the same. “Respect” for samples was a topic that came up with each of my participants, no matter which organism their samples came from. A hierarchy was not a sufficient model to understand and explore the multiple (and conflicting) cares that I observed or heard about. Furthermore, it followed the hierarchical thinking characteristic of modernism and science that I was interrogating. Noddings (1984) developed “concentric circles of caring” or “circles of care,” in which she connected care to proximity (1984: 54). Her argument was that care and the obligation to care is stronger for people within immediate circles of proximity and less for those in distant circles. In other words, we care more and are obligated to care more about that which is close to us.

I started to think with Noddings’ (1984) “circles of care” in relation to Alison’s argument, specifically the argument she made about the lack of care outside the laboratory. This was particularly interesting as Alison expanded her argument:

> So, I had specific people in mind when I said that and they were in the audience. But then one of them came to me afterwards and said, “Yeah, but I care so much in the lab so that I get these things right so that the humans can be cured or whatever.” But what I think care is, is not only doing what you're comfortable with, it's going beyond yourself and challenging yourself with things that are uncomfortable. That’s care. Because if I just cared about this little thing in the lab, then that’s not really care, that's just within my comfort. And one of these people specifically said they're not interested in community engagement. Why must they do community engagement? They don't want to teach. Why must they teach? It takes away from the lab time. So that is a selfish thing because even though you're saying you care about this, you only care about that for what? Is it really to benefit the human at the end of the day or is it about your career trajectory or about your career success and, in turn, also sort of helps humans? So, I think people really have

> to re-evaluate what care is for them and whether they actually care about humans and whether it's selfish motivations for doing things. Because superficially everyone can say I'm doing this for the betterment of humanity, but what really is driving you? And I think that's the underlying thing. And we don't have care. Even doctors, do they really care for their patients?

Alison was speaking to the tensions between care and proximity, and scientists only caring about what was included in their immediate circle of care. For Alison, caring meant moving beyond that circle, out of the comfort zone, and making an impact beyond the laboratory. In her argument, this has to do with community engagement, teaching and being involved in something that "takes time away from the lab time." This refers to all the things that do not "count" as part of scientific research. Here, scientists move from being concerned to caring, where caring involves action and time spent.

I cannot speak for the person that Alison was referring to. Each of my participants cared about many things beyond the laboratory, beyond their immediate proximities or circles of care. What they cared about was not limited to the bacteria and cells with which they worked inside the BSL3. This is the body of ethnography that informs Chapter 5. But what Alison highlighted was the very real disconnect between science and society. Alison's argument has led me to argue for the importance of care in science beyond the laboratory and a more caring science – being one that *connects* the laboratory and community – as a way to decolonise science. Caring beyond the immediate proximity of the lab is going to be what it takes to decolonise science. Chapters 5 and 6 each explore why this is so.

IMAGINING CARE'S POSSIBILITIES FOR SCIENCE

Alison's critique was highly useful. It showed the "selfish," uncaring side of science and the importance of thinking about a science that cares. After the presentation, I received an email from one of the heads of the division who attended. He wrote:

> Thank you for a very thought- provoking presentation of Friday
> I was particularly interested with your observation of scientific care and the question of whether scientists show care beyond their niche or current experiment.

> I wondered whether care should be seen as the reason for doing research that has an impact, i.e. translational research is the product of care.
> Hope this makes sense.

In another email, he wrote:

> I think that your comment on impactful research outside of the lab is key to whether a scientist is doing good research. All to [sic] often we are measured on our outputs and not whether they impact – do we care? We need a mindset change to do research that cares rather than fitting care to the research that we are doing… I would really like to see care being the primary focus and research being the tool to demonstrate care.
> Somehow you need to instil this into the minds of many scientists.

There are many important points here. Among other things, these emails speak to what the industry of science values or "counts." Scientists need to value and care about those same things if they are to be successful. They need to produce particular outputs, they need to publish and they need to get funding – which favours particular outputs. Rather than valuing or counting the impact that scientific research has in society, the parameters of success reinforce the separation between science and society. The shift that is suggested is that care is foregrounded so that it comes before the scientific research. What this means is that science needs to be reunited with society so that society drives what scientists care about. When applied to science, the ethics of care, with its emphasis on relationality, connection and interdependency, urges for the weaving of science and society in ways that centre what would be valuable for all. This "all" includes humans, more than humans and the planet.

As the emails from the head of division imply, what is needed is a shift from concern to care. What if science placed care at the centre? What if we implemented this "mindset change" that the head of the division alluded to? What would the world of science look like? What would a science that values care look like? What does a more caring science look like? What would that science value? Since relationality and interconnectedness are at the heart of care, I weave back to the threads of Haraway's (2008, 2016) relational ontology and sympoiesis, Margulis' (1991) holobiont as well as the sociable weaver nests as I imagine. A caring science

is not just a translational science, but a *relational* science. It builds and weaves relationships as well as maintains them. Relationships across modernist binaries, relationships with communities, relationships with the public. I elaborate on this in the following chapters.

CHAPTER 3 – SCIENCE AND THE BODY, AND THE BODY OF SCIENCE

Grace and I were in one of the division's many laboratories while we waited for an antibiotic to kill the bacteria in the extracellular environment of the macrophages. At this point in her experiment, TB bacilli have infected the macrophages, and any remaining bacteria outside of the macrophage needed to be killed, otherwise they would infect the macrophage and kill it. The macrophage needed to be alive so that Grace could observe what happened inside the cell. She was tracking a protein called "parkin" that was involved in ridding the cell of the bacteria. We left the BSL3 and went to prepare the chemical that would be used to "freeze" the experiment so that whatever was happening inside the cell would "stop" for Grace to see it outside the BSL3 using a specialised super-resolution microscope. While Grace began preparing the chemical at the bench, she said to me, out of nowhere, "Someone told me that being a scientist is using your whole body, all your senses."

Grace propelled me to think about and with the body of the scientist in scientific research. She situated scientific practice in the body, moving beyond the mind/body Cartesian dualism so characteristic of both modernity and science (see Scheper-Hughes & Lock, 1987). In this chapter, I explore how "being a scientist is using your whole body" and "all your senses" in order to show the subjectivity – the personal – in scientific research. I use this to argue that science is produced by people and not separate from the social. This calls into question the assumed neutrality, objectivity and authority of science, following the work of scholars such as Ludwick Fleck (1935), Maurice Merleau-Ponty (1945), Michael Polanyi (1958, 1966), Thomas Kuhn (1962), Bruno Latour (1993, 1999, 2004), Isabelle Stengers (2000, 2010, 2011, 2018) and Lesley Green (2020). The point of this is not to critique the scientific method or the validity of scientific data. The point is to dissolve any idea that science is separate from society and the laboratory is separate from the world.

Grappling with the science/society binary – the assumed separation of the lab and the world – is a central trope of this thesis. But importantly for this chapter, by asking whose bodies are conducting science, or in other words, science *from where*, allows space to think about what

determines where scientists look. Do they look to contribute to science that gets read by other scientists or that which is driven by what society needs and cares about? This weaves the groundwork that is required to assemble the argument on decolonisation in the final chapter. “Matters of concern” (Latour, 2004), a concept that I engage with in this chapter, begs the question of whose concerns inform scientific research.

Significantly, in this chapter I argue that my participants understood many of these concepts deeply. My ethnographic research shows that we cannot lump scientists together, accusing them of being unaware of the ambiguities of science. It was precisely this disconnect between what is written about scientists in academia (particularly what I read about them in the medical anthropology courses I took in both my undergraduate and postgraduate studies), and what I knew about scientists through my personal experience that propelled me further into this research. This will become very clear in my participants’ reflections of science that are discussed in this chapter.

“BEING A SCIENTIST IS USING YOUR WHOLE BODY”: SENSING AND KNOWING

The exploration of sensing in science that follows in this section is a combination of three threads. The first is Grace’s reflection on the use of the various senses in science that came after her statement that “being a scientist is using your whole body, all your senses.” The second is examples from my other participants that demonstrate the use of the various senses in scientific research. The last thread is my own observations and descriptions of sensing from my experience of being in the laboratory with my participants. Grace said, “A lot of things we do are abstract… so you have to look for other ways to be able to see them and know them.” This section speaks to the relationship between sensing and knowing. The aim is to show how the body and its senses are fundamental in scientific research. Doing science is doing sense-work, or what Natasha Myers has referred to as “bodywork” (2008).

Sight was vital to scientific research. Many of my participants identified TB through sight. Individual bacilli were “too small to see” with the naked eye, but because the bacteria liked to “clump,” the clumps could be seen without the aid of technology. I saw these clumps a lot

on Leigh's plates inside the BSL3[43]. Part of her protocol involved growing patient sputum samples at the end of their TB treatment on plates to see whether or not they still had TB. On one of my first days observing her inside the BSL3, she brought her plates to the hood and looked through them[44]. She held up a plate to show me, and I looked at the lumpy growths. "That's not TB, that's another organism," she said. Picking up another plate, she said, "I know what TB looks like." I looked at the flat, flaky, cream-coloured "colonies" on the plate that she was holding. "That's a lot of TB. So now I know for sure this patient has TB," she said. From looking at a plate, Leigh could tell which growths were *Mycobacterium tuberculosis.* Picking up a third plate, she said to me, "This is almost like a mountain and TB grows flat." She then pointed to the wells that contained samples that she was going to "grow up" and culture, "This is classic *not* TB. Do you see the yellow colour?" Leigh said[45].

After the samples were grown on plates, Leigh needed to "scrape" the colonies off the plate. Referring to one of the plates, she said, "This doesn't seem like TB just because of the way it's scraping off… TB just lifts off." Then, referring to the plate that she thought had another organism growing on it, Leigh said, "This I'm really curious about – it scrapes like *Mtb.*" Based on how the colony scraped off the plate, Leigh thought that it could, in fact, be *Mtb*. The colonies that were scraped off the plates were put onto small glass slides. These slides would be heated on a heating block inside the laminar flow cabinet to kill the bacteria so that they could be taken outside the BSL3 and stained using dye (see Image 5). The slides would then be put under a microscope to *observe* what was growing and *see* whether it was *Mycobacterium tuberculosis.* Tuberculosis bacilli form very distinct shapes (see Images 1 & 2). This diagnostic tool is known as Sputum Microscopy and it relies solely on human sight to diagnose TB.

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[43] "Plates" was the term used for agar plates, which are Petri dishes that contain growth media with certain nutrients used to grow microbes.

[44] "Hood" refers to the laminar flow cabinet in which my participants worked with *Mtb*. It is a safety cabinet that uses mechanised airflow to separate the inside of the cabinet from the outside, ensuring that particles and microorganisms do not move between. This prevents contamination of samples inside the cabinet as well as prevents pathogenic or harmful bacteria from leaving the hood and posing a risk to the scientists.

[45] "Wells" refer to the trays that contained multiple small test tubes.

Image 5: **A photo of Alison's stained slides**, before they were placed under the microscope (see Images 1 & 2). Photograph courtesy of Alison.

My participants could *see* whether MGITs (Mycobacteria Growth Indicator Tubes) had mycobacteria growing inside them, or whether the tubes were contaminated with other microorganisms[46]. When Alison checked on her MGITs inside the BSL3, she took them out one at a time and gently flipped the tube to have a look inside. She said to me that the "balls" inside looked like *Mycobacterium bovis* because *bovis* forms these characteristic balls. One of the samples that Alison picked up had a bigger ball, leading her to say that it looked like "something else." Leigh, Alison and Emily's projects relied heavily on sight. Making ZN stains, they used their sight to determine whether their samples were positive for TB. I observed the entire process of culturing samples to make ZN stains, and I was lucky enough to stain some

[46] MGIT is a test tube placed into a scientific instrument that detects mycobacterial growth and, very simply, is used to determine the presence of mycobacteria (or viable microorganisms) in a sample (see Image 7). If the instrument in which MGITs are placed detects life in the form of respiring microorganisms, scientists can culture MGITs to determine what microorganisms are present. In the context of this research, MGITs were used to detect *Mycobacterium tuberculosis* or *Mycobacterium bovis.*

of Alison's slides that were cultured from lion tissue samples. When we looked at the slides under a microscope, Alison asked if what I was looking at was *Mycobacterium bovis.* Gazing through the lens of the microscope, I saw the characteristic worm-like pink bacilli that clump together (see Images 1 & 2). Explaining why the bacteria clumped, I remembered a participant in my honour's research project saying to me that "TB needs friends" (Shain, 2017). The sample I looked at under the microscope showed these friendly groupings. It was indeed positive. The samples that were negative did not have these characteristic traits (see Image 6).

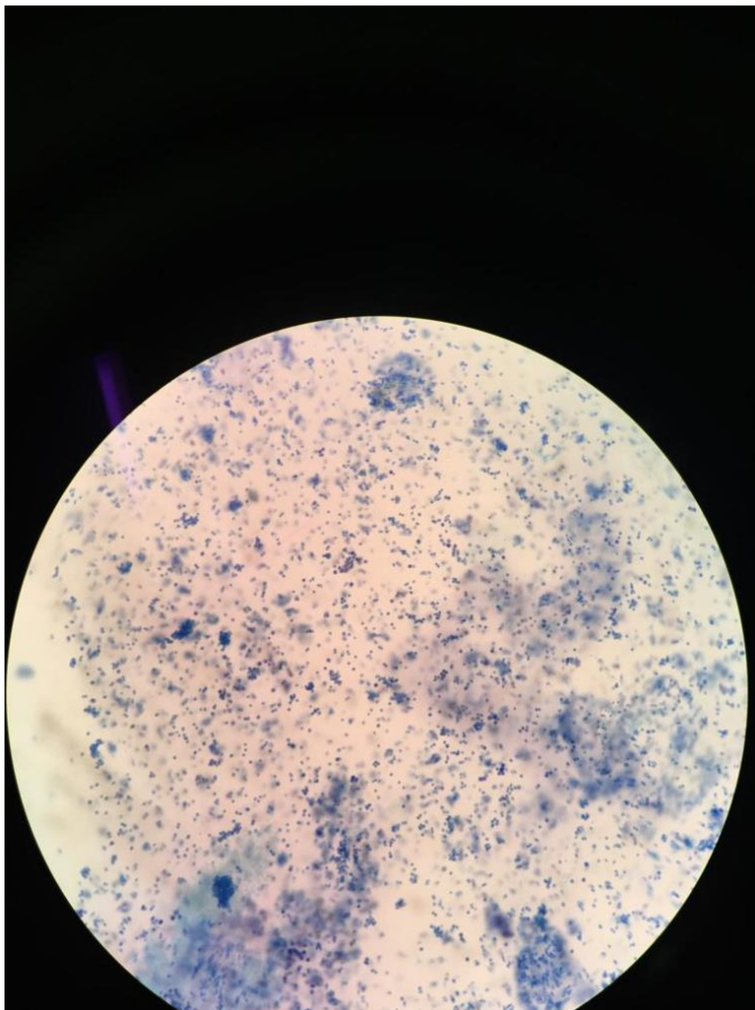

Image 6: **A Ziehl-Neelsen (ZN) stain, as seen through a microscope**. ZN stains are a form of smear microscopy used to detect and diagnose tuberculosis (TB). This particular slide does not show the characteristic features of *Mycobacterium bovis*, and therefore shows another organism or microbe. Photograph courtesy of Alison.

Sight was used all the time: to tell when cultures were ready, when bacteria were not growing, when new media needed to be added or when cells were "happy." Grace checked on her cells every single day. She explained that the colour of the media indicated different things and that the colour indication would vary depending on what media was being used. For Grace's

cell cultures, if the media turned pink, it meant that the culture had been exposed to the environment. If it turned yellow, it meant that the nutrients were depleted. Orange was the optimal colour, showing that everything was just right. Grace would look at the colour of her cultures, but she would also perform another visual check. She would place the flask under the microscope to see "how they are doing." She explained, "like babies can't speak for themselves, so you have to be observant, like how mothers do it."

Grace said, "With the bacteria, I don't know a lot, so I have to be careful around it… I don't know *Mtb*. I know the cells." She explained that she was "more careful" with the bacteria because they were more "unpredictable" than cells. She could see the cells under a microscope to tell how they were doing. The bacteria, on the other hand, were "too small to see." Besides the colour of the media, Grace said that she could not see how the bacteria were doing or whether they were "unwell." That is why she said, "If I had my way, I'd work with the pink *Mtb* all the time." Grace highlighted the relationship between sensing and knowing. The "pink *Mtb*" referred to the bacteria in the pink media, where the colour indicated how the bacteria were doing. With the pink media, Grace was able to *see* whether the bacteria were "okay" and whether they were growing. Most often, the bacteria were in clear media, which led her to say that in the P3, it's "abstract," "I can't relate to it."

Observation and being observant were key. Specifically, they were key to *knowing*. According to Grace, "In biomedical research, those little things, the shape of your cell, it's saying something about… the colour, what colour is it, little things like that… you have to be very observant." This weaves into Leigh's observations of colonies and how they scaped off, and what that said about the organism that is growing. There was a relationship between seeing and knowing. Grace told me about a time in the lab whereby seeing *how* a liquid came out of the syringe, she knew that it was not the one she needed. Leigh said that "seeing is believing." Leigh liked to be able to see things to know that they were there, she explained. Interestingly, one of the goals of science is to be able to *see.* Grace explained, "Imagine if our bodies were transparent, then we could see exactly what was going on." She continued to explain that they are not, and so we need to try and understand what happens, to zoom in to understand the processes. Then she said, "That's why I like microscopy… you can *see.*" Grace's research was about infecting cells with *Mtb* to look at them under a very advanced microscope and *see*

what was going on inside the cell. If she could see what was happening inside the cell, she would get closer to understanding the infection process in humans, when TB infects our immune cells. The more that is known about the TB infection process, the greater the potential for developing drugs that can kill the bacteria. But sight was not the only way to know. There was also a relationship between smell and knowledge.

The importance and value of smell in scientific research was not immediately obvious. Since a lot of liquids are "clear," Grace explained, scientists might occasionally use smell to distinguish between liquids. Grace said that acids had a "corrosive" smell and to demonstrate this, she let me take a gentle whiff of one of the acids that she used in the laboratory. Speaking about *E.coli*, Grace said, "the bacteria have a distinctive offensive smell" and that everyone knew when scientists were working with them because the whole lab would smell[47]. Interestingly, smell was also used to discern contamination. "Before you see it, you can smell cells have been contaminated," Grace said. Here, there was an intimate relationship between smell and knowing. This relationship continued inside the BSL3.

Grace spoke about the significance of smell for ensuring the safety inside the laboratory. She used her sense of smell to establish whether the PAPRs (Powered Air Purifying Respirators) were operating safely[48]. I recall her asking Alison and me while we were in the BSL3 whether we smelled the ethanol that she had just sprayed. We all smelled it faintly. She and Alison said that ideally, we should not be able to smell it since the PAPR should be fitted so that no particles enter it. Ultimately, you would want a mask that completely blocks you from the outside and outside particles, including smell particles. This was why Grace asked me whether I smelled a difference when I took off my PAPR mask, explaining that that was how she knew whether the mask was "safe." There should be a distinct difference in the smell of the air inside the mask, and the smell of the air when the mask was taken off. This is because the PAPR filters the air inside the mask. Noticing the differences in smell was an indicator of

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[47] *E.coli* or *Escherichia coli* are also a type of bacteria. They are used in TB science for a number of reasons, such as acting as "hosts" to reproduce *Mtb*'s proteins and DNA. Their fast growth rate makes them favourable. A participant in my honour's research project told me that they are considered "the workhorse of the laboratory" (Shain, 2016: 11).

[48] PAPRs are a battery-operated air filtration system that is comprised of a battery pack worn around the waist, with tubing that connects to a mask or face-piece which covers the face and shoulders. They are worn in environments where there is a high risk of aerosol transmission of pathogens.

safety. One day, while I was putting on my gown in the clean room before going inside the BSL3 with Grace, I noticed it had a strange smell. When I told Grace about the smell, she asked whether it smelled like "burnt." It did. She explained that if the autoclave machine that had been used to wash our gowns – a safety protocol to kill potential bacteria on the gown – did not have enough water inside it, the gowns would smell like that. Here, smell was used to "know" whether my participants were safe or at risk.

Hearing and being able to discern sounds in the laboratory were also extremely important. Grace explained the importance of "listening." The laboratory was filled with sounds, alarms and beeps that a scientist needed to be constantly aware of. "When you hear a beep, you need to know what is happening," Grace said. The autoclave machine sang a song when it was done and the centrifuge let out loud beeping when it stopped[49]. Some sounds needed immediate attention. The alarm of the incubator beeped one day when Grace did not close the door properly, indicating "the carbon dioxide content is too high." Grace quickly went to close it. The high content of carbon dioxide could be detrimental for the cells and bacteria growing inside the incubator. The fire alarm required a quick response too. One afternoon while Marina and I were inside the BSL3, there was a sudden loud alarm. Marina said it was the fire alarm and immediately got up to look around the laboratory for any signs of a fire or smoke. When she saw no sign, she called the laboratory manager to find out whether there was a problem and whether we needed to leave the lab. Luckily, it was a false alarm. Perhaps one of the most important sounds inside the BSL3 was the sound the PAPR battery pack made when the battery was low, Grace explained. Should you hear this sound, you needed to act quickly to get into the ante-room before the mask stopped supplying air. The mask could not be taken off inside the BSL3 because there was the risk of breathing in *Mycobacterium tuberculosis.*

Another sound that was often heard was the phone ringing or a scientist outside the BSL3 knocking on the glass window between the lab and the corridor outside. Both were to

[49] A centrifuge is a device that spins a substance at a high speed, separating compounds within the substance based on their density. It was often used to get *Mtb*. In Leigh's protocol, the centrifuge was used "to spin TB down to form a pellet." The pellet of *Mtb* could then be sucked up with a pipette and placed on a slide or in a well to grow.

communicate with a scientist inside the lab. Since getting into the BSL3 involved time-consuming protocols of getting properly clothed in protective gear, scientists would often ask each other for help with small tasks like putting cells in the BSL3 incubator or removing an item from the BSL3 to be used in another laboratory. This weaves into the care for colleagues that I write about in Chapter 5. By the end of my fieldwork, I was also able to recognise the different sounds of the laboratory, such as the beeping of the centrifuge when it was done and the song of the autoclave machine in one of the BSL3 labs.

A QUICK INTERJECTION: SHATTERING PERCEPTIONS OF SCIENTISTS

What I found interesting was how the soundscape of the laboratory reminded me of a kitchen. The beeps of the machines reminded me of kitchen appliances like dishwashers and washing machines. The rumble of metal balls breaking apart animal tissue in a small dustbin-like machine called a homogeniser reminded me of making smoothies in a blender. The singsong tune made by the autoclave machine when it had completed its cycle sounded like the tunes that newer washing machines make when they are done. My associations of these sounds were not very “science-y.” I began thinking about how sensory experiences conjure up images and ideas of other places. The soundscape of the BSL3 laboratory shattered my perception of laboratories. The soundscapes of the laboratories that I spent time in for this research were also fun, and human. What I mean is that they were filled with chatter and laughter from scientists, conversations about friends, boyfriends and children and even music on a few occasions. I am reminded of Sarah Franklin when she writes, “the lab is a very sociable place” (2013: 78).

Speaking to the idea of perceptions of laboratories, I cannot help but think about the time when Leigh took her culture flasks out of a container and they were covered in drawings. Right there inside the laminar flow cabinet were millions of deadly bacteria inside flasks covered in drawings and speech bubbles made with a black marker. “It’s the small things that keep you going,” Leigh said, smiling. Leigh explained that she and a colleague started drawing on the culture flasks for fun, and then on one occasion when they did not draw pictures, the bacteria did not grow. They continued to make drawings for fun and to make each other laugh:

> I mean I guess sometimes it's good to inject fun in our thing. We do so many repetitive things that, you know, us drawing pictures on cultures is also like, it perks me and [my colleague] up. I always laugh because she draws me really funny pictures and vice versa. So, we try and like have fun as much as we can… *I think that there's definitely outside perceptions of scientists – that we're super nerdy and we just stick in our labs, wear our little white coats, and we don't have fun or creativity and stuff.* But that's actually, I think some of the most creative people I know are in this building.

What is interesting here is the playfulness, creativity and "un-science-y" stuff that made its way into the sterile environment of the lab, especially the BSL3, which had to be extremely sterile to ensure safety of the humans, cultures, samples and experiments inside. These aspects remind us that science is produced by people. The point is that science is not separate from the social, and this matters in the weaving of the larger argument about dissolving the boundary between science and society, the lab and the world. But before I continue this discussion, there were other senses that I have not yet addressed.

BACK TO THE SENSES

Science involves touch and touching. Experimental scientific research is an interplay between fingers and a range of objects, subjects, tools and technology. Sometimes, touch was used for distinction. Grace told me about the paper she was using for an experiment. "This feels different," she said, running her fingers over it. She "felt" that it was different to the paper she had used in previous experiments and when she checked the order, she was right. "It made me feel good that I was able to notice the difference," she said. In the next chapter, Chapter 4, I use touch to question where the human body begins and ends to think about scientists' entanglements with bacteria, cells, organisms and technology. In this way, touch offers a path into thinking about how subject/object boundaries were broken within the laboratory space. The next chapter focuses solely on touch because it complicates ideas of boundedness between human/more than human and self/other more than any other sense. Furthermore, touch allows for deeper exploration into the subjective in scientific research – a prominent theme of this chapter that is woven shortly. And lastly, touch collapses the boundary between the laboratory and the world beyond it in significant ways, as the next

chapter argues. But for the purpose of this chapter, there is an element of touch that must be discussed here. This has to do with the other aspect of touching; namely, *feeling.*

Puig de la Bellacasa writes, “If seeing stands for *believing*, touching stands for *feeling*” (2017: 102, original emphasis). There was another kind of sense that was present in scientific research, what Grace referred to as “gut feeling.” As I have explained, the bacteria liked to clump. Part of the process of de-clumping *Mycobacterium tuberculosis* involved using a syringe and needle to suck up the bacteria from a tube and squirt them back into the tube. The clumps of bacteria split when they entered the very narrow needle so that when they were ejected back into the tube, they were no longer clumped. In Grace’s case, they could then be used to infect the macrophages. It was important that individual bacteria infected the macrophages, not clumps, Grace explained. This process of sucking the bacteria up and squirting them back was carried out many times for a single tube. I asked Grace how many times she did this. “Sometimes, I try to count till 100. Sometimes, until I’m tired. But I just trust my gut feeling,” she explained. On another occasion, in a conversation about the importance of sight in scientific research, Grace held up her pipette, looked at it and said, “You need to have your sense of judgement… I’ll know if it doesn’t look right.” She then said, “A lot of times, if you feel something is wrong, something is wrong. You train yourself to notice those things and believe in them.” Grace speaks to embodied knowledge that has been accumulated over time, or what Tim Ingold calls “skill” (2018). I discuss this in the next section, because it applies to each of the senses and sense-making inside the laboratory.

Ironically, the BSL3 was an environment that minimised the ability to sense, and for good reason. The Personal Protective Equipment (PPE) that we were required to wear to protect ourselves from the environment inside the BSL3 had an impact on the senses. I felt that my senses were dulled inside the BSL3. The PAPR masks, with their plastic screens, could sometimes affect sight if the screens had some dirt or oil on them. One day in the BSL3, Grace said that her mask was “blurry” and that had affected her being able to see the cells under the microscope. It was extremely difficult to hear over the constant sound of air that came into the PAPR mask and over the loud rumbles of the laboratory machines. Touching was always through two layers of gloves or by means of technology such as pipettes. Smell was, for the most part, taken away because of the masks. Most of the time, all that could be

smelled was the mask and the air entering it. Taste in the BSL3 was completely absent because of the masks and the dangers that taste and ingestion would pose. I do, however, recall a participant in my honour's research project speaking about using taste to distinguish between two liquids that had no smell. But this was not inside the BSL3. I have provided a detailed account of the senses in the laboratory because there was a significant relationship between sensing and knowing, and between the body and knowledge.

SENSING AND KNOWING: EMBODIED KNOWLEDGE

Philosopher of science Michael Polanyi calls this embodied way of knowing through the senses "tacit knowledge" (1966). According to Polanyi, tacit knowing, although "an *actual knowledge*… *cannot be explicitly stated*" (1966: 4, emphasis original). Grace's "gut feeling" was tacit or embodied knowledge that was gained through experience. Polanyi calls this "trained perception" (1966: 2) or "scientific intuition" (1966: 6). Ingold refers to this as "skill" (2018). Ingold (2018) contrasts his theory of skill with Pierre Bourdieu's concept "habitus" (1977). Skill does not bypass awareness or the conscious mind in the way that habits do (Ingold, 2018). Ingold explains that skills are acquired over time and "depend upon a highly attuned attention to multiple dimensions of environmental co-variation" (2018: 162). Skill is therefore reflective, conscious and responsive (Ingold, 2018: 161). This kind of attuned attention is precisely that tacit, embodied (intuitive) knowledge. Polanyi argued that *all* knowledge and thought is rooted in the body (1966: 10). Even "explicit knowledge must rely on being tacitly understood and applied" (Polanyi, 1966: 7). Polanyi (1996) therefore argues for the phenomenology of science, laying some of the groundwork that connected scientific knowledge to the body. Others have explored this as well, as I discuss below.

Oliver Human writes about what "the rings around Jonathan's eyes" show about the embodied knowledge that is gained through experience and used to make clinical diagnoses (2012). His participant, Dr Mira, said to him in an interview, "there are TB symptoms that I can't put on a list, which is in the way they walk into the room, the way they look at you… that kind of chronic infection look, which seems to make these kind of very round circles on the patient not easy to see" (Human, 2012: 26). Human argues against the idea "that knowledge is disembodied and, therefore, can be modelled into a universal protocol" (2012:

27). He shows how evidence is deeply embodied. This challenges the Cartesian mind/body split so characteristic of Western biomedicine much like the way Nancy Schepher-Hughes and Margaret Lock's "mindful body" challenges it (1987). Extending this to think about embodiment in science, Natasha Myers (2008) makes compelling observations in her ethnographic research inside laboratories.

Myers centres the "body-work" of structural biologists to show how they quite literally embody the molecule "to come to grips with – and so make sense of – molecular forms and functions" (2008: 166). Annemarie Mol (2002) and Karen Barad (2003) refer to this as "enactment." I think with Myers' work more deeply in Chapter 4 as I explore the ways in which my participants were entangled with their cells and samples. Myers' work is important because she collapses the boundaries between "the intellectual and physical labour of research" to "challenge narrow conceptions of 'thinking' as a cerebral activity, and make visible the craftwork, creativity, and embodiment of scientific reasoning" (2008: 169). Myers (2008) therefore situates knowledge production within the body. Astrida Neimanis speaks about this in her beautiful account of "embodying water" when she argues, "thinking is also an embodied act; concepts are also embodied. We understand them because our bodies as finely attuned sensory apparatuses live them, in one way or another" (2016: 41). This echoes Polanyi's (1966) theories around the body and knowledge in science.

What each of these scholars have in common is the acute understanding that knowing, through its intimate relationship with the body, is deeply personal. Polanyi writes, "All tacit knowing requires the continued participation of the knower and a measure of personal participation is intrinsic therefore to all knowledge" (1966: 14). This is why Polanyi has made a case for "personal knowledge" (1958). Since "being a scientist is using your whole body, all your senses," scientific knowledge is also personal because it is situated in the body of the scientist. The point is that by situating a discipline that is founded on the idea of objectivity in the thoroughly subjective space of the body, the notion of a science devoid of people becomes impossible to think with. People are intimately involved in the production of scientific results. The following section takes this argument further.

"WHY DID THE SCIENTIST CHOOSE *THAT* THING?": ALISON, MERLEAU-PONTY AND UNPACKING SCIENTIFIC OBJECTIVITY

I was in the BSL3 with Alison and Grace, watching them complete an infection protocol. Grace was in front of the laminar flow cabinet, "rinsing" the macrophages that were infected with three different strains of *Mtb* the day before. She rinsed them to get rid of any extra-cellular bacteria, which were the bacteria in the media that did not infect the macrophages. After rinsing them, Grace gently scraped them off the surface of the wells, sucked them up with a pipette and put them into little tubes with chemicals that would break them open. Once broken open, the bacteria that infected them would be released and its DNA would be extracted and analysed. Sitting next to Alison, I was very aware, almost self-conscious not only of my role as an observer, but of the subjectivity of my research. In my fieldnotes, I wrote, *Little bit worried… am I looking in the right places, am I missing things, what do I take down and why, how does it further my own goals and "twist" the direction of my research to a "preferred" outcome???* Looking up from my notes, I asked Alison whether she minded being observed. As if responding directly to my thoughts, she said that she also had thought of herself as "an observer," "an anthropologist." She explained that science was just "observation" and the making of conclusions based on those observations. Since her description of science had so much to do with observation – processing through the senses – and analysing and making conclusions based on the researcher's observations, I asked her about the subjectivity of science.

Alison said that everything was subjective, including scientific research. She explained that a researcher made an "individual" and "subjective" choice to look at a "particular thing" rather than "something else." "Why did the scientist choose *that* thing?" she asked rhetorically. This weaves back to Alison's questioning of whether scientists actually cared about society or whether they were conducting science for "selfish" reasons. It also speaks to the email that was sent to me by the head of the division about what determines good science – getting published or making impact. Impactful science is science that is driven by what society needs and cares about. For the purpose of this chapter, with its focus on the body, Alison echoed the kind of thinking that informed much of the theory of embodiment and phenomenology in relation to science, and much of the groundwork that birthed the field of science studies.

In *The Phenomenology of Perception*, first published in 1945, Merleau-Ponty connected the theory of embodiment and phenomenology to scientific research and the production of scientific results. Using the framework of phenomenology, he argued that we perceive and experience the world through our bodies. Specifically, through our senses. The knowledge of the world is therefore thoroughly tied to a "particular point of view" (Merleau-Ponty, 2007: 134). This has obvious implications for science, which is an attempt at understanding the world. As Lock and Farquhar remind us, "To *have* a body means inevitably that one is embodied; consciousness can exist only as mediated through experienced embodiment" (2007: 6). Since our perception of the world is fundamentally embodied, Merleau-Ponty (2007) challenged the assumed objectivity of science. This in no way implied that scientific knowledge or facts are invalid. Rather, Merleau-Ponty's (2007) argument showed the connection between scientific research and the subjectivity and subjecthood of the researcher. His point, and Alison made this very clear in her response about the subjectivity of science that I described above, was that "to see [is] always to see from somewhere" (Merleau-Ponty, 2007: 148).

Scientific research is *always* a view from somewhere, a view from *someone* or some*body* to be precise. Polanyi (1958) argued this too with his concept of "personal knowledge," which aimed to reject "the ideal of scientific detachment" and show "the *personal participation* of the knower in all acts of understanding" (1958: n.p., original emphasis). This philosophical argument is picked up in Puig de la Bellacasa's (2017) matters of care. Polanyi argued that personal knowledge "does not make our understanding *subjective*," it merely highlights that "into every act of knowing there enters a passionate contribution of the person knowing what is being known, and that this coefficient is no mere imperfection but a vital component of his knowledge" (ibid, original emphasis). Merleau-Ponty (2007) and Polanyi (1958) reminded us of the often-forgotten reality that scientific research is produced by *people* and is therefore not devoid of the social.

The assumed objectivity of science can mask the fact that research is mediated by the perceptions and lived experiences of the researcher. Merleau-Ponty (2007) highlighted the centrality of perception as mediated through the body, and therefore also challenged the authority of science. Merleau-Ponty understood that perceptions *create* worlds, challenging

any assumption that what scientists observe is "just there" (Green, 2020: 15). This is precisely the distinction between ontologies and Jacques Derrida's "hauntologies" (1994: 10 in Green 2020: 15-16). The latter shows how concepts are laced with or haunted by particular ways of knowing and being. In other words, certain perceptions (or mediations, or "concerns," as Latour (2004) argued and to which I turn in the very next section) *create* certain realities. What science believes to be true is simply that, *a* truth and not *the* truth. Merleau-Ponty (2007), having dealt with these concepts in the 1940s, is a precursor to some of the foundational arguments in the field of science studies, which formed some decades later.

Science studies was founded on the critique of scientific authority, since it questioned the objectivity of scientific facts with an argument that showed the relativism of scientific knowledge – or how facts are socially constructed. Stengers traces these claims to Ludwick Fleck's *Genesis and Development of a Scientific Fact* (1935), which was the inspiration for *Structure of Scientific Revolutions* written by Thomas Kuhn in 1962. Kuhn's (1962) work mobilised many different collectives in the 1980s including philosophers of science, critical theorists, feminists, sociologists of science and postcolonial theorists (Stengers, 2018: 86). Common to these collectives was the goal of "show[ing] that the sciences were a social practice like any other" (ibid)[50]. To these collectives, the demoting of scientific knowledge to social construction was liberating (Stengers, 2018: 86). Multiple ways of understanding, knowing and being could be recognised and accepted. Scientists, on the other hand, were outraged and what ensued is well known as "the science wars" (ibid). A discussion of some of the fundamental concepts of the field of science studies is therefore relevant, and it lays the foundation for the argument to decolonise science offered in Chapter 6.

[50] Anthropology was not immune to these critiques. The "Writing Culture" debate that occurred around the same time highlighted the subjectivity and positionality of anthropological research, calling into question the authority of anthropological knowledge (see Clifford & Marcus, 1986). Can anthropologists' claim to "write culture"? the debate asked. The anthropologist's subjectivity, perceptions and positionality both within their own culture and the culture of those they research guide that research in very particular ways. Reflexivity became an important part of ethnography to dispel any claims of objectivity and authority. I have inherited these critiques, and therefore tread carefully, writing myself into the ethnography to show how this research is produced from my particular point of view, from my perceptions, from my body.

"LOOKING FOR ONE SPECIFIC SEED": FROM MATTERS OF FACT TO MATTERS OF CONCERN

Sometimes theory drowns out, dwarfs or speaks over ethnography. I have noticed in my own writing that the need for theory to speak to the ethnographic fieldwork could hide that it was the ethnography that came first. Long before I even knew about the field of science studies with its founding arguments, Alison was raising the same concerns. Our conversations in the laboratory involved so many of her astute reflections of science. She was already *doing* the theory long before I was reading about it. In this chapter and throughout, I insert the voices of my participants so that their expertise not only operates alongside the literature and my own theoretical weaves, but *before* it. Latour writes, "Is not being moved, or rather, put into motion by the informants exactly what we should mean by an enquiry?" (2005: 48). The chronology is important. Time, as I argued in Chapter 1, is significant.

In an interview with Alison, she provided an insightful reflection of science. Her response below comes to matter again in Chapter 6, and not just because it connects science to the politics of race. What is significant about Alison's reflection is that it speaks to one of the most influential concepts in the field of science studies, namely, Bruno Latour's (2004) "matters of concern." Alison said:

> I want to be floating because I feel like life is not about solid – this is the way it has to be, this is what I have to do. And I think a lot of scientists see that that is science, but that's not science. Science is about, science should be more like anthropology. It's not about okay I have a hypothesis, I must test it. Okay let's try something, someone has said this, let's try it and let's observe what happens. But now you do targeted sequencing, so you look for something so specific in a specific arena. It's like going into a football field, cordoning off the one side and looking for one specific seed, and that is where you go and do your experiment. That's not science, and people like to think that… We had Leonard Gentle here from the MRC [Medical Research Council], he is now doing public engagement and stuff. And he was talking about, you think that your science is so unbiased, but yet these ideas that are dogma, were already perpetuated by the thinking of the time. So, there were Apartheid ideas like race differences that it's genetics, it's genetics and whatever and, you know, intelligence is genetic, attached to the race. And then people went and investigated that. And from that finding, even though they say no

> it's not a race whatever, there's something from that finding that's only a finding because you've already stratified the groups out and now you looking for something so specific and then people have now run with that. Whereas if you didn't stratify, and you just had a mix of people, that would have never come out.

What Alison articulated is how scientific facts arise because of very subjective concerns – specific framings, set and bounded by people with specific thoughts and perceptions. As I outlined in Chapter 2, Latour (2004) – a pioneer of science studies – developed the concept "matters of concern" as a response to scientific "matters of fact" for this very reason. Matters of concern exposes that scientific *facts* are merely outcomes of particular *concerns*. If the concerns shift, then so do the facts (see also Green, 2020).

Latour (2004) draws on Martin Heidegger's (1967, 1971) exploration of the etymology of the word "thing" to distinguish between matters of fact and matters of concern. At the centre of Heidegger's writing is the difference between a *Thing* and an *object.* According to Heidegger (1967, 1971), "Thing" is closely related to the word "gathering" in European languages. For Latour, "A thing is, in one sense, an object out there and, in another sense, an *issue* very much *in* there, at any rate, a *gathering*" (2004: 233, original emphasis). The gathering represents the things, people, concerns and politics that surround the object and bring it into being, making it a T*hing*. The difference between "matters of fact" and "matters of concern" lie in the difference between objects and Things, respectively. Matters of fact ignore the "thingness of the thing" (Heidegger, n.d. in Latour, 2004: 245). In other words, matters of fact ignore that objects are always Things, always gatherings, always brought into being by multiple concerns. The point of matters of concern is, therefore, to show that scientific facts are socially and politically constructed, not objective expressions of natural laws (Puig de la Bellacasa, 2017: 30-31). Alison highlighted this social construction in her reflection.

Stengers writes that matters of concern "insists that we think, hesitate, imagine and take sides" (2018: 3). What she alludes to here is that matters of fact are not devoid of the social, they are matters of concern, with interests and politics, precisely "cosmopolitics" (Stengers, 2010), which she termed to theorise the politics surrounding the Thing, the gathering, the matters of fact that expose the matters of concern. Matters of concern – or cosmopolitics –

show that science is not independent of society, not independent of politics, not independent of certain interests. Therefore, "What is of primary concern to one community of scientific practice may not be a priority for another. Specific concerns frame specific questions and therefore also the answers" (Green, 2020: 100). There is no such thing as context-free science. Science is not "outside" society. The laboratory and the world "outside" are never separate, as I try to show again and again in different ways. Science does not happen in a vacuum. Any claim that the laboratory is a neutral, value-free space needs to be unpacked.

The point of this critique is not to invalidate science. The point of this argument, which forms the backbone of science studies, is to show that scientific "facts," because they are produced by particular concerns, are never neutral[51]. This means that "the question of knowledge politics is at the heart of science and technology studies, and not just as an 'externalist' problem about how politics might affect knowledge and science production" (Puig de la Bellacasa, 2017: 29). Therefore, as Stengers reminds us, matters of concern get us away from assuming there is one "right answer," urging for "hesitation, concentration and attentive scrutiny" (2018: 3-4). This requires slowing down. Part of this hesitation, concentration and scrutiny means taking on Green when she writes, "The question 'What am I seeing?' needs to be expanded to include 'How and why am I seeing what I am seeing?' Defending good science requires addressing with equal seriousness the question of what good science is. What are its concerns?" (2020: 99). This weaves back to the care debate and the email, making further threads and connections to interrogating the difference between what science values and what *good* science values, and whether the two are compatible. Good science being science that is relevant and impactful – notions that are discussed in the chapters that follow. Implicit in this argument is that any claim to authority that science makes comes from particular concerns. This brings scientific claims of authority to the foreground.

[51] Latour (1993) argues that "we have never been modern" because the very thing that has characterised modernity – the neutral and objective scientific fact – has been called into question.

“BACK OFF, MAN… I’M A SCIENTIST”: SCIENTISM

A friend sent me a GIF of Bill Murray’s character in the film *Ghostbusters* saying, “Back off, man… I’m a scientist” to end a debate that we were having. Ironically, I was writing this section on the authority of science when this happened. The GIF perfectly encapsulates how science has become synonymous with authority, truth and reality, with scientists as brokers thereof in many public perceptions. It just takes someone saying, “it’s science” for a statement to be validated, or “I’m a scientist” for someone to quite literally “back off.” Christopher Colvin has called this, “the play of power within science that always exceeds the terms of its discourse” (2012: 49). This is what has been referred to as “scientism.” While science is “a reliable way of producing knowledge through experimental processes,” scientism is “the belief that all scientists produce neutral, transcendent, natural knowledge that is permanently and totally separate from society, regardless of context” (Green, 2020: 38). Scientism disguises itself as science, gaining certainty, authority and power. This is precisely the authoritarianism of science. Judith Farquhar defines scientism as “the unquestioning faith of moderns and modernisers in something – one thing– they call science” (2012: 156). Scientific outcomes, particularly in public perceptions, are assumed to be matters of fact rather than matters of concern.

There are serious issues with scientism under the guise of science. Its neutral “outside society” position hides how its so-called facts may authorise patriarchy, racism, capitalism and white supremacy (Green, 2020: 105). “Truth” claims can be used to justify hegemony. Neutrality and objectivity may mask discrimination. “Objectivity” ignores the intimacy of the scientist in the research and the multitude of their concerns. This is why Green argues that science and scientists need to “resituate scientific authority” by finding “humility” (2020: 218). Green’s (2020) call for humble scientists parallels Stengers’ (2018) call for “civilised scientists.” “Civilised scientists” are scientists who are aware that their science represents a particular matter of concern and is therefore reliable only within the constraints of that matter of concern (Stengers, 2018: 101). According to Stengers, these scientists “would make it public… that the very particular conditions… come at the price of ignoring what may be important factors outside of the laboratory” (ibid). As I have described so far and what I offer in what follows, I argue that the sweeping generalisations about scientists that lead to these

calls are often inaccurate. Ethnographic work with scientists shows that scientists challenge what we (as social scientists) think about them. The reality of scientific experiments in the laboratory, and my participants' thoughts, show that scientists are fully aware of the doubt and uncertainty in science. My participants were already humble and civilised scientists: questioning, hesitating, doubting.

SCIENCE IS MESSY AND "IMPERFECT": "FLITTING IN AND OUT"

Leigh told me about the "big contention" around the existence of persisters:

> So, there's a problem defining in the field what is a persister, what is a tolerant microorganism and what is a viable but non-culturable organism. Are they all the same? Do they all fall under the same umbrella? We're not really sure. There's like a very stochastic nature to these organisms. They're always flitting in and out.

Leigh's use of the term "stochastic" was very interesting. The word comes from the Greek word "stokhos," which means "aim" or "guess." Interestingly, a scientist speaking about modelling proteins in Myers' ethnographic research said:

> A lot of *guesswork* goes into [building a structure]. And guesswork isn't the best word to use; maybe *subjective* would be the best word to use to describe it. And that's not something you can understand until you actually have a structure that you have done yourself, or are in the middle of doing. The first structure I did was an easy one. I was really surprised that it was up to me to put in [amino acid] residues. It was up to me to put the [polypeptide] backbone in. I was just really surprised. … That it was something that I could make a mistake and no one would know. It's kind of scary, and it makes you really wary about other structures sometimes (2008: 183, emphasis added).

Myers' (2008) participant shows the guessing that goes into science, highlighting the "subjectivity" of scientific outputs and the possibility of mistakes. In this way, Myers (2008) opens up about the uncertainty and doubt surrounding scientific research. Scientists are not unaware of the uncertainty of science. Leigh also spoke to the uncertain nature of science:

> I mean that's the problem with science, right? We're dealing with imperfect systems. We're dealing with a patient that has an immune system. Some people eat really well, some are smokers and some don't. So, it's so hard to pinpoint and just be like it is because of this. And I think that's science in general. Like we can't just be like it's because of this, let's go home. It's never that simple and it's not going to be, but that's why we all need to target it from different angles so we can provide different answers and different ways of answering the question.

Leigh's response showed that there is never closure, never completeness. Leigh had a deep understanding that scientific questions require multiple *concerns* to answer. But Leigh also pointed to the disconnect between the laboratory and its need for perfect systems, and the world outside, which is "imperfect." It seems absurd that the laboratory, an environment so unlike "the world," is the space in which to understand the world and make truth claims about it. Yet it can never really "know" the real world because of that disconnect. In my research, it was explained that it was difficult to study how the bacteria actually behaved in human beings. "Ideally you want to get a human, infect that human with *Mtb* and dissect that human, that's the ideal. But then you have to work with what you have," Grace explained. Scientists tried to mimic the environment of the lungs to speculate what happens in the human body when *Mtb* infects our immune cells. When you try to mimic that, you run into difficulty, because, as Leigh alluded to, humans are not controlled variables. They exist in the world, they vary. Expanding on this inconsistency and lack of control in scientific research – particularly clinical research, – Leigh said:

> Like I've always had issue with the sample I get. Maybe the patient that day wasn't coughing a lot of sputum and he gave me a pot of saliva. So, that's why we have to do such huge numbers to actually see an effect or see if there is anything real. Because you have so much variability. And that's the issue with clinical research and that's what I don't like about clinical work. Although you feel like you're making an impact on patients, there's so much that's out of your hands, that you have no control over, that you have to just deal with it and do much larger numbers. You know when I was doing abalone infections, I'm responsible for the infections, I bleed them, I do all of that. So, I'm in control from start to finish. Nothing can really go awry unless I've messed up. There [with

> clinical research], something can happen with the transport, or like the clinic receiving the sample. There's so many things that can go wrong, I have no control over that.

Working with clinical samples from outside the laboratory involved a lot of uncertainty. Emily's research continues the discussion of uncertainty in science:

> I've got this data set of the rhinos so far… I run them like every month. So, the vet there, he, we had like a rhino result afternoon meeting… I was in front there and I had to tell them about my results. So, his questions were like, 'But then Daisy in September was this. And in August was like this. Why?' It was positive in September and then negative in August and then we all had to brainstorm around this… The pressure. The expectation… There's the social aspect of it where your results, your being careful in the lab, your interpretation of your results, it has a huge [impact]… Because every farm that sends their samples, we do report back. But how we report means a lot because that's what they know.

Interestingly, Emily spoke to the same subjectivity and doubt that Myers' (2008: 183) participant did. Science depends on "being careful in the lab" and it is dependent on "interpretation." Both of these elements are very personal. Emily also spoke about "how" she reported back and determined "what they know," pointing towards the kinds of realities that scientists create. All of these elements weave back to the messy and imperfect nature of science. "Experimentation is a risky enterprise: experiments do not promise ease and assurance," write Myers and Dumit (2011: 244). Science is not stable, it is "in flux" (Myers & Dumit, 2011: 245). This is seen with Emily's data sets, as they oscillated between positive and negative TB diagnoses. This was also embedded in Alison's words when she said, "I want to be floating because I feel like life is not about solid – this is the way it has to be, this is what I have to do. And I think a lot of scientists see that that is science, but that's not science." Rather than being solid or static, science is more fluid, like "floating." It is an ongoing *process*. This weaves back even further to science and the in-between. Myers and Dumit write, "Experimenters must be agile as they navigate between extended periods of disorientation and moments of insight" (2011: 244). It is always an unpredictable becoming. This speaks to the *indeterminate* nature of science.

Thomas Csordas (1990) interprets Merleau-Ponty's (1962) argument, writing "far from being constant, perception is by nature indeterminate. There is always more than meets the eye, and perception can never outrun itself or exhaust the possibilities of what it perceives" (Csordas, 1990: 8). Because of this, science – the product of perception – has to remain available to multiple becomings because of its unpredictability and indeterminacy. Newton himself spoke about the indeterminate nature of the cause of gravity, the gaps that science cannot explain (in Green, 2020: 88). I weave this to Aimé Césaire's argument about the gaps of scientific knowledge when he writes, "Poetic knowledge is born in the great silence of scientific knowledge… Physics classifies and explains, but the essence of things eludes it" (1982: 17). The point is not to dismantle scientific integrity, the point is to open up spaces of doubt so that science never becomes scientism, and so that it becomes impossible to imagine that scientism could ever pass as science. And yet although the indeterminate nature of science leaves space for the emergence of other concerns, there is danger in questioning the authority of science.

While much of the push to decolonise science comes from questioning the legitimacy that arises from its unfettered authority and "naturalness," there are real dangers of critique. Leigh was deeply aware of the increasing disbelief in science and the consequences thereof, such as lack of funding, diminishing public support and climate change denialists. Although Latour fathered matters of concern, he warns against a critique of science that leads to disbelief or mistrust in scientific matters of fact (2004). For this reason, Latour (2004) argues that "critique has run out of steam." Puig de la Bellacasa (2017), on the other hand, disagrees with Latour (2004). She writes, "In a deeply troubled and strongly stratified world, don't we still need approaches that reveal power and oppressive relations in the assembling of concerns?" (Puig de la Bellacasa, 2017: 39). Matters of care, developed from matters of concern to show the care (or need for care) behind scientific matters of fact and matters of concern, does exactly that. But in relation to this chapter, the importance of matters of care – as I argued in Chapter 2 – is that attention to care shows the "affective involvements" in "the researcher's experience" (Puig de la Bellacasa, 2017: 62). In other words, the personal in the scientific.

PERSONAL CONCERNS

Grace's statement that "being a scientist is using your whole body, all your senses" led me to an inquiry into the use of the senses in scientific research. What emerged was a relationship between sensing and knowing. Importantly, because of the use of the body, this became a very personal (and embodied) way of knowing. Situating an "objective" discipline in the thoroughly "subjective" space of the body, shows that a science devoid of people ("outside" of society) becomes impossible to think with. People are intimately involved in the production of scientific results. This was further supported by Alison when she said that a researcher made an "individual" and "subjective" choice to look at a "particular thing" rather than "something else." "Why did the researcher choose *that* thing?" she asked.

Her reflection follows the arguments put forward by Merleau-Ponty (1945) and Polanyi (1958) that challenged the objectivity of science by showing its connection to the researcher. Latour (2004) calls this "matters of concern." The subjectivity of scientific research is often ignored in the staging of facts as matters of fact rather than matters of concern. Alison's statement that conducting scientific research is like "going into a football field, cordoning off the one side and looking for one specific seed," further engages Latour's (2004) matters of concern. The point is to show that there is no such thing as context-free science. Science is not outside of people's subjective concerns, it is not "outside" society. The laboratory and the world are never separate, as I argue again and again. Science does not happen in a vacuum. Any claim that science produces objective knowledge in a neutral, value-free space needs to be unpacked. Since this is the case, it is important to slow down, hesitate and ask what the concerns of the scientific research are. What concerns shape science? Are they society's concerns? Are they relevant to society's problems? If scientists have a choice about what they research, what choices are they making? Who are those choices benefiting? Themselves or their communities? Who is science relevant to? Who does science serve? These are important questions for the decolonisation of science, as Chapter 6 highlights.

This chapter is important because while it expands on the central arguments of STS theory, – namely, the social construction of science – it does so with the acknowledgement that the ethnography came first. My participants were ahead of the theory. They had raised many of

these arguments during my fieldwork. They show that scientists cannot be lumped together as they are in accounts of science by scholars such as Stengers (2018) and Green (2020). Alison was raising matters of concern long before I had even engaged with this scholarship. My participants challenged what we, as social scientists, tend to think and write about scientists. They were profoundly aware of the central position of the researcher in scientific research. The following chapter, with its emphasis on touch, furthers the exploration of the personal in scientific research at the same time as it challenges what we think about science and scientists through its focus on the *connection* between scientists and their subject-objects as well as the laboratory and the world beyond it.

CHAPTER 4 – POROUS BOUNDARIES: TOUCHING, BEING TOUCHED AND BEING IN TOUCH

It seemed like everything that I watched in the laboratory involved liquid. Cells and bacteria grew in liquid media. Patient samples were submerged in liquid. Clear liquids were poured into other clear liquids during experiments. Culture flasks held beautiful pink liquid. Liquid was used to clean laminar flow cabinets. Spot plates, test tubes and culture flasks were full of liquids. Liquids were used to feed, liquids were used to passage, liquids were used to freeze, and liquids were used to kill. While sitting next to my participants in front of laminar flow cabinets, day after day, watching them work with liquids, I began to think about fluidity and flow. Donna Haraway speaks about "tentacular thinking" (2016). Basing this concept on the travelling and movement of a spider, *Pimoa Cthulhu*, she visualises the idea that "Nothing is connected to everything; everything is connected to something" (2016: 31). Interestingly, Karl Marx writes, "A spider conducts operations that resemble those of a weaver" (1990 in Franklin, 2013: 318n6). This tentacular thinking – the weaving of thoughts, the connecting of things to other things – allows for movement into all sorts of spaces and places, concepts and theories. Like the web of a spider, it generates as it connects. It is a generative practice. I expand the tentacles of my thinking around the body of the scientist, which I explored in Chapter 3, to arrive at thinking through entangling in ways that break the divisions between subject/object, human/nonhuman, subjectivity/objectivity and, finally, science/society. These "intra-actions" (Barad, 2003) of enveloping and being enveloped, enfleshing or "giving body" (Hopwood, 1999) and being enfleshed, were facilitated through touch. In this chapter, I move my tentacles into touch and how it facilitated relations of all kinds. It is important to remember that relations are a central aspect of care.

"I remember," Haraway writes, "that *tentacle* comes from the Latin *tentaculum*, meaning 'to feel' and 'to try'" (2016: 31). Thinking tentacularly, I explore the touching and the feeling of my participants. Importantly, touch becomes a way to think with the fluidity of boundaries and confuse the idea of boundedness. As I showed in Chapter 3, science is founded on the notion of detached touch, which simply refers to the objectivity that comes from separation

and distance between the observer and the observed, the subject and the object of scientific research. In the previous chapter, I argued that science is fundamentally embodied, involving all kinds of thoroughly subjective sense-work or body-work. Building on the arguments put forward in Chapter 3, this chapter takes the subjectivity in scientific research further by focusing solely on touch. Again, subjectivity does not refer to bias in scientific research. This discussion of subjectivity extends my exploration of subjectivity as "the personal" (Polanyi, 1958) within scientific research. Touch has further significance both because it is a neglected sense in social science (Puig de la Bellacasa, 2009) and because it complicates ideas of boundedness between human/more than human (see Castañeda, 2001) as well as self/other more than any other sense (see also Ahmed & Stacey, 2001; Marks, 2002; Radcliffe, 2008; Puig de la Bellacasa, 2009).

Another important dimension of touch is what Puig de la Bellacasa refers to as its "reversibility," (2009: 300) – that to touch is to be touched. This aspect of touch weaves into a discussion of the ways in which my participants were deeply touched by what they did. This furthers the argument of care within scientific research. Importantly, as discussed in Chapter 2, Joan Tronto's definition of care involves coming into *contact* (into touch) with the subject-object being cared for (1993: 107). Physical contact and the breaking of boundaries that is enabled through that contact is an important element of care. My participants touched and were touched, dissolving the boundaries that separated them from the living tools with which they worked and the world outside the laboratory. Touch shows the fluid nature of boundaries and confuses the idea of boundedness. The ability of touch to break boundaries, like the fluids that broke open the bodies of the cells, is important for thinking decolonisation with. Decolonising science, as the final chapter argues, involves breaking the boundary between the laboratory and the world. Touch assembles and brings together, creating and cultivating relations across divides. This is not a static process. Significantly, when things touch, they are brought together through movement.

Movement is another important thread, or tentacle, that needs to be woven into this fabric. Movement is a conceptual tool to begin thinking beyond static boundaries and binaries. If movement is brought to the fore, it becomes impossible to think about distinct separations between subject/object, human/nonhuman, living/non-living, subjectivity/objectivity,

laboratory/external world and science/society. Movement, like touch, is about connection. I think here about movement and the breaking of all sorts of physical, geographical and conceptual boundaries. I think about the movement of the bacteria into the macrophages, as they break open the cell wall (or boundary) to infect them. I think about the movement of *Mycobacterium tuberculosis* from one person to another, complicating the idea of bounded bodies. I think about the movement of TB across species boundaries, how humans can infect animals, animals can infect humans, and animals can infect other animals. I think about the movement of resistant TB strains across South Africa, as they move from one person to another. I think about the movement of wild rhinos and lions, and the movement of their TB. I think about the movement into and out of the clean room, crossing the boundary between the BSL3 and the world outside. I think about the movement of samples across vast geographical distances, and from the world outside to the world inside the laboratory. Movement and flow become a conceptual tool to theorise the porosity of boundaries and collapse modern and colonial boundedness. In Chapter 6, I offer an argument for decolonising science that involves connecting the laboratory to the world beyond it and understanding the flows and movement between the two. Movement and flow become important threads that weave the argument for a decolonised science. But to end up in this theoretical space, which I explore in the final chapter, I need to begin with ethnography. I have argued previously for the importance of the chronology. It was always the ethnography that came first.

"IT'S LIKE SPLASHING COLD WATER ON YOU": NARRATIVES OF ENTANGLEMENT

I met Grace in her office one morning and we walked together to the Tissue Culture Lab. She led me through a door into a small room where she handed me a lab coat. She opened a second door and walking inside the small laboratory, she said proudly, "This is my favourite place on campus." I looked around the dim-lit cosy laboratory where cells lived. There was no one else inside, it was warm from the incubators and the only sound came from their quiet hum. I could easily understand why Grace loved being here and working with the cells. I followed Grace to the basin, where we both washed our hands before putting on a pair of gloves. I was getting used to these protocols. This would protect the cells from any contamination on our hands. Grace walked over to one of the hoods and pressed a button. The lightbulb flickered on and the hood rattled to life. Grace took a spray bottle, tore off some

paper towel and began cleaning the hood. This ensured that her cells would not get contaminated. Anything entering the hood was also cleaned for this reason.

Grace then walked to the incubator, opened its two doors and took her culture flasks out. She walked slowly and carefully to the hood and sat down. I pulled up another stool and sat down next to her. She was going to “passage” her cells, she explained. Cells were “passaged” or “subcultured” – grown and regrown from an original batch of culture – many times to make large quantities of the cell stocks needed for experiments. Passaging, however, could not go on forever. Grace explained that “like humans, when you get old, you get weak, unreliable... The cells are the same.” After passaging them fifty times, “they are now old and tired and won’t give good results.” On every culture flask there is a “passage number,” which “shows the age of the cell.” The cells that were in front of us had been passaged forty-two times. The contrast between cells as babies and cells as old and tired points towards the cycle of life in the laboratory space. Cells are conceived, they grow up, they grow old and they die.

“Cells are living beings… they don’t like being pushed around violently,” Grace said as she began passaging her cells[52]. Part of this process involved mixing the culture. The culture needed to be put in a machine that spun it three thousand times per minute. Grace said that the cells “don’t like it” so “it’s all about compromise.” To compromise, she spun the cells at “the slowest possible speed.” She also warmed up the growth media in the incubator so that it was thirty-seven degrees Celsius, “otherwise it’s like splashing cold water on you, you don’t like it.” Grace told me that cells “love” to grow in clumps, “because, like humans, they love to be together.” Cells grew on the surface of the culture flask, which was why the flasks were always placed lying down rather than upright to ensure the greatest surface area for the cells. Once their growth started accelerating, there were obvious problems. “So, like people crowded together, once they start bumping shoulders, they don’t like it… you have to find a balance,” Grace explained. “They need each other, but it cannot be too crowded inside the flask.” Grace continued, “They need to communicate, they send messages to their neighbours” and so “they are really like humans… if you put them alone, they get lonely and

[52] Wakana Suzuki writes, “They are living beings,” about the cells in her anthropological research inside a stem cell laboratory (2015: 102). This resemblance points towards the relevance of this research beyond the scope of this research project.

depressed." This pointed towards the care of the cells inside the laboratory, which depended upon a profound understanding of the lifestyle of the cell and what made it happy. This weaves back to Chapter 2. But for this chapter, what I am interested in here is the way in which Grace was tactually interpolated into the laboratory experience of the cell through her narrative.

Natasha Myers (2008) as well as Myers and Joe Dumit (2011) write about the "entanglement" of scientists with their data sets, elaborating on how they develop a "feeling" for the molecule to enact its structure through their bodies and come to know it. This entanglement takes place through the scientists' bodies, but also through their narratives about their science. Myers and Dumit explain that one of their participants articulated "how scientific storytelling is a process of inserting and orienting oneself *inside* a phenomenon, and playing through possible narratives" (2011: 243, emphasis added). Eva Hayward, writing about the encounters between humans and jellyfish inside an aquarium, has called this "immersion," which "conveys the experience of being totally inside a world" (2012: 173). Both entanglement and immersion ring of Michael Polanyi's concept of "indwelling," which is a knowing from the interior (1966). Knowing from the exterior creates "alienation" and "loss of meaning" while indwelling means that "we *interiorise* these things and *make ourselves dwell in them*" (Polanyi, 1966: 10, emphasis original). Polanyi therefore stressed the importance of *feeling* in understanding (1966: 11). Interestingly, Polanyi (1966) was writing about scientists and science, and he argued that scientific meaning and knowledge can only be gained from this intimate interiorisation or indwelling.

The way in which Grace spoke about the cells, the narrative of what they did and did not like and how they *felt* spoke to this orientation of her as a scientist *inside* a cell. As she played with this narrative, she enfolded with her cells as she enfleshed them by bringing them to life. At the same time, she was enfleshed by them, in the sense that she *felt* what they felt, whether it was the feeling of cold water on skin, being pushed around violently, or feeling lonely and depressed. Polanyi argued that indwelling is a process that "develop[s] new faculties in us" (1966:10). Hayward calls this "sensuous rapport" and "energetic cadence" (2012: 165), which captures the intimacy of interpretation and understanding in multispecies entanglements. Wakana Suzuki analyses the language used by her participants to show the

ways in which “the qualities of the cells… enter into our body” (2015: 99). Suzuki writes about the same kind of entanglement that her participants had with their cells whereby the boundaries between cells and scientists’ bodies are blurred (2015: 102). Grace, like Suzuki’s participants, entangled with her cells, or as Vinciane Despret would argue, she engaged in an “anthropo-zoo-genetic practice” of “becoming with” and “becoming together” (2004: 122). This is a practice that encapsulates how human and animal (be)come together. In other words, it is a multispecies “merging” (Suzuki, 2015: 102). According to Ludwig Fleck, discovery is a “relationship of active, living intervention, a reshaping and being reshaped, in brief a creation” (1979: 48 in Myers & Dumit, 2011: 248). This speaks to how science is made in these entanglements, in what Karen Barad has called “intra-action” (2003) or what Sarah Franklin has called “integration” (2013: 77). Each of these scholars write about the entanglement of the scientist with their phenomena whether cells, molecules or data sets. But, importantly, each of them argues that this entanglement is a *prerequisite* for knowing rather than a *product* of it.

Scientific knowledge comes from this deep immersion. Detached touch becomes impossible to think with. Barad argues for “knowing in being” since “We do not obtain knowledge by standing outside of the world; we know because ‘we’ are of the world” (2003: 829). Knowing in being breaks the human/nonhuman, subject/object, mind/body, matter/discourse separations (ibid). Grace viewed, perceived, understood and described the cells by and through imbuing them and their social lives with human subjecthood and experience. In Chapter 2, I explained that cells and bacteria were referred to as babies. In a handful of cases, they were also referred to as “guys” or teenagers. Leigh said things like, “Okay, now these guys are ready to be incubated,” “I’m going to leave this guy for longer” or “What is this guy?” Alison described the infection process as “a school dance.” With a 10: 1 bacterium to macrophage ratio, “not everyone is going to be asked to dance, so not every bacteria is going to infect the macrophage.” At the beginning of this section, I showed how Grace described the process of cell aging through the lens of human aging. This did not counteract the baby metaphors, instead this showed how scientists created metaphors and used anthropomorphism to help them understand and explain in particular moments how they needed to care for their living tools as well as understand and explain the lifestyles and activities of these living tools.

Conducting good experiments required knowing cells and bacteria and treating them the way they wanted to be treated, which was interpreted through the way humans want to be treated. Haraway writes, "We relate, know, think, world, and tell stories through and with other stories, worlds, knowledges, thinkings, yearnings" (2016: 97). Myers writes about her participant, a professor of chemistry, "According to Diane, crystallographers must rely on what she calls 'known knowledge' to 'interpret what otherwise would be completely un-interpretable'" (2008: 183-4). We observe and make sense of the unknown through the known. George Lakoff and Mark Johnson, known for their work on metaphor, write that "Perhaps the most obvious ontological metaphors are those where the physical object is further specified as being a person. This allows us to comprehend a wide variety experiences with nonhuman entities in terms of human motivations, characteristics, and activities" (1980: 33). Like Suzuki wrote of her observations inside a stem cell laboratory, laboratory technicians "can be *cellularized* at the same time their cells become *humanized*" (2015: 102, original emphasis). This humanisation was clearly seen in the metaphors that made up my participants descriptions and stories, which blurred the human/nonhuman and object/subject boundaries.

The blurring of humans and nonhumans as well as humans and technology have been central to explorations in STS. Franklin (2013) shows how scientists inside laboratories not only make (human) babies, but make "lively relations" with the living tools and technology with which they work. This can be traced to Karl Marx's work on the symbiosis between humans and machines (1990) and echoes Haraway's "cyborg" (1985, 1991) as well as Latour's "hybrid" (1993). While I am not going to theorise the entanglement and relationality between humans and technology, I want to use this idea of more than human entanglement as a conceptual tool to think about relationalities across boundaries and the importance thereof[53]. And to

[53] Although I do not theorise human-machine relationships for lack of space, I do not ignore how my participants were entangled with tools and technology nor how bodies and technology came together to create hybrid humans, breaking all sorts of subject/object, human/nonhuman, nature/culture divides. My participants became with various technologies and tools to do science *together*. These included gloves, pipettes, hoods, centrifuges, autoclaves, incubators, fridges, computers, PAPRs, flasks, tubes, racks, bottles, spray bottles, microscopes, MGIT tubes, BD BACTEC MGIT systems, FACS Jazz machines, spectrophotometers, and heating blocks to name just a few. For the porosity of bodies in contrast to the dominant Western paradigm see Haraway (2008, 2016) and Neimanis (2016). For embodied entanglement between human and technology see Polanyi (1958), Merleau-Ponty (1962), Haraway (1985, 1991), Latour (1993), Franklin (2013) and Puig de la Bellacasa (2017).

care is to create and maintain relationality, as I discussed in Chapter 2. One of the pathways to conceptualise these relationalities is the stories that are told in more than human entanglements, as I have shown with Grace.

These stories require creativity and imagination, what Myers and Dumit have called "haptic creativity" (2011). Haptic creativity describes the creative process whereby scientific data, obtained through technology, is interpreted through the body. Technologies become "responsive media" (Myers & Dumit, 2011: 240) as scientists engage in performativity or "body-experiments" (Myers & Dumit, 2011: 244). In other words, they come to understand and know scientific phenomena through their bodies, as they move their body in ways that aim to mirror what they are trying to communicate verbally. Media becomes embodied (Myers & Dumit, 2011). Although I did not observe this kind of physical performativity, through Grace's stories – her bringing of the cells into her body and world, and her body into the world of the cells – she also practiced haptic creativity. It was a different kind of body-experiment, but a body-experiment nonetheless. In both cases, scientist becomes with scientific subject-object in a thoroughly embodied way. For Grace, it was through a narrative that reflected a scientist trying to understand the subjects with which she worked by bringing them into her (human) body, to know them, so that she could treat them better and care for them.

This is an intimate venture. Puig de la Bellacasa writes, "the *haptic* holds promises against the primacy of detached vision, a promise of thinking and knowing that is 'in touch' with materiality, touched and touching" (2017: 95, emphasis original). Hayward also speaks about the centrality of the body and its senses in immersion, and the closeness and intimacy required for truly knowing. She writes, "the tactile visuality, or *fingery eyes*, relies on textured proximity rather than objective distance; look but don't touch doesn't work here" (Hayward, 2012: 174, original emphasis). That science calls for "detached vision" (Puig de la Bellacasa, 2017: 95) and "objective distance" (Hayward, 2012: 174) – what Polanyi referred to as "scientific detachment" (1958: n.p.) – is complicated by the haptic, by touch. Touch is an intimate form of knowing because it involves connection. Touching takes senses and embodied subjectivity a step further because it breaks bodily boundaries. Explorations of

touch compliment Haraway when she asks, "Why should our bodies end at the skin?" (Haraway, 1991: 178). But more interesting is what happens when bodies do not end at the skin, when boundaries are dissolved, when bodies are touch and are touched. Touch, and the closeness it requires, brings caring to the foreground. "Once one has been in touch, obligations and possibilities for response change," Haraway writes (2008: 97). Once one has touched, it can be hard not to care. The following section elaborates.

"THAT MOMENT WAS LIKE THIS CRITICAL TURNING POINT IN HOW I VIEWED MY RESEARCH AS A CLINICAL RESEARCHER": TOUCHING AND FEELING

Puig de la Bellacasa writes about the "reversibility" of touch, that to touch is to be touched (2017: 20). Thinking about touch and its reversibility in relation to TB is interesting. We are touched by TB and TB touches us: we breathe it in, it touches – comes into contact with – our lungs and sometimes other parts of our bodies. Based on her ethnographic research in an informal settlement on the outskirts of Cape Town, Fiona Ross wrote about being "touched by TB" (2010: 174). "A 'touch' of TB is to have experienced a mild form, to have had the disease diagnosed and treated before deep damage to the lung tissue – 'scarring' – has occurred" (Ross, 2010: 174-175). Conversely, inside the laboratory TB was *untouchable.* Scientists went to great lengths not to come into direct contact – touch – with the pathogen. There were layers and layers between humans and bacteria inside the BSL3. Gloves, pipettes, syringes, test tubes, masks, glass divides and invisible curtains of air separated scientists from the bacteria (and cells). But this did not stop the kind of intimate touching and *feeling* that happened between scientists and their living tools across various technologies, as I have argued by describing the care that happened inside a scientific laboratory. But what about care beyond the laboratory?

The root of Alison's argument that I explored in Chapter 2 and the email response I received from a head of the division was around scientists being *out of touch* with and *detached* from the world beyond the laboratory. "Because if I just cared about this little thing in the lab, then that's not really care," Alison said. But Haraway (2008) and Puig de la Bellacasa (2017) argue that one can rarely touch without being touched – though it is possible. My participants

touched and were all touched in some way. For some, like Alison, the touching of others was not enough. She argued that scientists were out of touch with the world beyond the laboratory. For others, the way in which they touched was enough – impactful enough, caring enough. This was raised in the responses from other scientists that Alison received after my presentation, and to which she referred in Chapter 2. This connects again to Haraway's tentacular thinking when she explains that "Nothing is connected to everything; everything is connected to something" (2016: 31). In relation to the debate on whether scientists care, it must be noted that it is impossible to touch everything or care about everything, though in my research there was always touch and care for something.

In line with connections, Leigh described her research as "the middle ground between the host and the bacteria." Her description of the middle ground speaks to being in touch with both the bacteria and the human and weaves connections to the idea of the in-between and the importance thereof. While I have spoken about her relationship with the bacteria, I have not spoken about her relationship with humans. Leigh's research was directly linked to a clinic where patients went to receive their TB treatment. At one point, her research required her being there to collect patient sputum samples through a procedure known as a bronchoscopy. This procedure involved inserting an instrument into the patient's nose or mouth and moving it down their throat to collect the mucus in their lungs. The process was "very invasive," Leigh said to me one day as she placed the slides that she had made from the patients' sputum under the microscope. We were both sitting in "the ZN room" – the room the division had allocated to staining slides and observing them under a microscope. I always thought of this room as a creative space because of the Jackson Pollock-like stains the ink left on the countertops from years of staining. The images that I would observe under the microscope were no less artistic (see Images 1 & 2). It was seeing these kinds of images, in fact, that led to the idea for the art exhibition that I curated (see Image 3). Leigh's slides were carefully laid out next to her. She picked up a slide, placed it under the microscope and began telling me a story about a patient whose sputum sample tested positive for TB after completion of treatment. Leigh made it known to the clinic that he had not cleared the infection, but because her test was research based, it was not considered a validated diagnostic test. The patient was not put onto treatment and he died. Leigh told me how hard it was for her to

know that the patient still had TB, but that she could not do anything about it. She could not sleep for two weeks.

This was exactly the kind of "scientific detachment" (Polanyi, 1958: n.p.) or what I have called *detached touch* that scientific research calls for. Leigh's dilemma was trying to navigate what Polanyi termed "the personal" (1958) in clinical trials where worlds are worlded in particular ways that do not allow for this kind of thick entanglement to which touch leads. Justin Dixon refers to these as the "ordered separations" and notices "the relational-affective dimension they obscure" (2013: 1). Dixon's ethnographic research highlights the care that clinical trial researchers provide research participants beyond their given protocol, arguing that "the line between experimentation (distanced, objective, representational) and healthcare provision (affective, relational, transactional) has become remarkably thin" (2013: 6). Although scientific research does not generally permit getting involved, this does not stop researchers from caring. These lines that Dixon (2013) speaks of are porous.

Touch, as in the collapsing of boundaries and the "connectedness" that Puig de la Bellacasa's framing of touch speaks to (2017: 97), brought Leigh into contact with the human and she was touched – in the sense that she was deeply affected – by her touching. This is precisely the reversibility of touch. This was not some sort of detached touch. Her touch led her to care, and as I have outlined in Chapter 2, what distinguishes care from concern is action. Although Leigh said that it was hard for her to "not be able to do anything about it," she did in fact do something. Leigh reported all of her results to the nurses even though the diagnosis was not officially recognised and even though she was not required to do so. In the face of protocols that distance the scientist from scientific subjects, Leigh created space for caring that connected across the researcher/researched, lab/world and science/society boundaries.

Inside the laboratory, Leigh remained connected to the patient as well. One afternoon, I was observing her prepare two patient samples. She explained that one patient had been on treatment for four months and the other for six months. While transferring the sputum into new tubes and adding a chemical that would kill any other organism that might contaminate the sample, Leigh said to me that this was an important study because "TB drugs are horrible to take." She said that she has a lot of respect for patients taking TB drugs. "I can't even take

a multivitamin every day and that's nothing compared to TB drugs," Leigh said. This speaks to Leigh's *feeling.* One of Haraway's guiding questions in *When Species Meet* (2008) is "Whom and what do I touch when I touch my dog?" This question is valuable to think with. When Leigh touched the sputum samples, it was obvious that she was not just touching her postdoc research. She was touching a sample with the awareness that it belonged to a human being. She empathised with that human being, inserting herself into their world, weaving back to Polanyi's concept of indwelling (1966). She entered their world of swallowing pills and brought it back to her world with her inability to regularly swallow pills, collapsing the boundary of the interior and exterior of the laboratory and the imagined disconnect between scientist and scientific subject-object. There was clearly a sense of connectedness and *feeling*, but as I have shown, there are also limits to how connected a scientist can be. Scientific research, with its strict protocols, sets up boundaries in its call for detached touch, or as Leigh describes in the story below, disconnection.

Leigh told me a story while she prepared some sputum samples inside the BSL3, using a pipette to suck up some of the sample to put on a slide for a ZN stain and some more for the wells where it would be left to grow for six weeks. There was an old man she once collected a sample from when she was in the clinic. "He came in for his bronchoscopy and he was happy and in good spirits even though he had to have this awful procedure done," Leigh related. She explained that the patients often came from precarious circumstances. When I had my first meeting with one of the heads of the division to present my research project and receive permission to conduct fieldwork, he noted the significance of the division's geographical placement right next to a government hospital and at the centre of an area known for its abject poverty and high rates of TB. The division's connection and relevance to the outside world was highlighted at the onset of my research, but it was not until I began conducting fieldwork with Leigh that I saw how the two were brought together. For Leigh, this involved deeply personal encounters. Leigh said that the old man who had come in for his bronchoscopy had put on his "best clothes," but she immediately noticed his "old and tattered shoes." Leigh said that her heart broke. "I wanted to buy him a new pair of shoes or give him a lift home or help him in some way," but she could not because she was not allowed to get involved, she explained. Leigh was a scientist strictly there for research. In her interview, she said:

> Yeah, I mean I think that story I told you about that old man's shoes. I don't know why it was just something that just like struck really deep inside me. And after that every sample I receive, I'm like 'who did this come from?' Even if I don't know the patient, I always imagine their face or where they come from, where they live and what they had to do, and whether they are walking home this afternoon. I don't know, that moment was like this critical turning point in how I viewed my research as a clinical researcher… There was a moment for me where it's like with these patient samples, with that man that I will never forget. It was so important for me and it just changed how I viewed everything after that.

Leigh was deeply touched by the encounter. Important to note is that being in touch with one of the humans who provided the samples meant that her samples were brought to life. They had stories and faces and they connected her to the world beyond the laboratory. Importantly, they connected her to the people. That Leigh referred to the patient as an old man rather than a patient, and that she put a face to her samples showed how she humanised them. This ensured she never forgot that her samples came from people. But beyond this, Leigh showed empathy for the patients, which came from the kind of indwelling I have been describing. She oriented herself inside the world of the patient as she thought about who the sample came from, what their face looked like, where they lived, what they did and how they got home after visiting the clinic. Michael Slote argues that "empathy is the primary mechanism of caring" (2007: 4). In other words, it is empathy that motivates actions of care. While empathy is "the contagion between what one person feels and what another comes to feel," sympathy does not have this kind of visceral connection (Slote, 2007: 13). For Slote, the difference between empathy and sympathy is precisely this entanglement and indwelling. Ingold (2015) might disagree. Drawing on the work of Lars Spuybrok, a design theorist, Ingold writes that "sympathy is a 'living with' rather than a 'looking at,' a form of feeling-knowing that operates in the interstices of things, in their interiority" (2015: 24). Sympathy in this definition has the thick entanglement, the becoming with, the intimate touching, feeling and indwelling. I also think about Henry Wallace's "sympathy with the plant" (Culver & Hyde, 2000: 518 in Hubbard, 2003: 796) that I referred to in Chapter 2, which also communicates the kind of "feeling-knowing" that Ingold (2015) speaks of, and which is characteristic of empathy in Slote's (2007) conceptualisation. Whether empathy or sympathy, the point is that

Leigh's scientific practice involved deep connection that facilitated care. This contrasted the kind of disconnection that could happen in scientific research, as Leigh explained:

> I think we tend to, as scientists, receive a sample that it's easy – especially when you're a student – to forget where it came from. So, I think the scientists that work on microbial cultures and everything, there it's very easy to disconnect yourself from it. But we have a lot of students who work on clinical patient samples who perhaps have not always been as careful as they should be. And I always tell them 'you're working with a *patient* sample.' But I think unless you've been in the clinic and you've seen the patients being bled, going for ethics, consent, a bronchoscopy and all of that, it's hard to drive home that this actually, this part that you're receiving, this urine, actually came from a human being.

What Leigh suggested was that unless a scientist has been in touch with the world in which patients gave sputum samples, it was hard to care. As I have argued, with touch comes the kind of entanglement that orients a scientist into the world of the researched. This led, as I have shown with Leigh, to care. Because of this reversibility of touch, Puig de la Bellacasa asks whether there can be detached touch (2017: 99). As Leigh explained, being in touch with the world in which the samples came from meant that it was hard to disconnect. Once touched and in touch, the deeply personal, the messiness of relationalities, made their way into the septic laboratory. Leigh elaborates:

> But I think that's where I am lucky in that [my supervisor] really immerses me in the clinic and I see where [the sample has] come from. I see all these patients from all walks of life. And you start attaching emotions to these people in your samples. I think in a way it does make you a better, more careful researcher. You shouldn't be emotionally invested in that you want a certain outcome. I think you should take utmost respect for the patient sample you have. I think sometimes people forget that a human being provided the sample. Yeah sure, taking blood isn't that painful, but someone had to be recruited from the clinic, drove over, missed a day of work and everything. So no, you can't take an extra tea break while your blood sample is sitting on the bench, which does happen. So, I don't know if I'm specifically good at that or if I've just had an environment that has allowed

> me to really understand and respect where my samples come from. But I think it's important, especially for clinical research.

Leigh spoke about how being in touch with the world beyond the laboratory made for a better and more careful and caring scientist. Emily's experience paralleled this. When Emily went to the wild rhinos to bleed them and take their blood samples back to the laboratory, she said that it "changed everything." Up until that point, she was working with samples that had been sent to the lab. Leaving the laboratory and coming into contact – into touch – with the living creatures who provided her samples created connection. She began calling the rhinos her babies. Leigh and Emily embody the kind of "humble" and "civilised" scientist that Green (2020) and Stengers (2018) call for. For Leigh, this was an extremely intimate embodiment. She interiorised the world of the patients as she thought about their personal narrative, what they had to do to get to the clinic and whether they had to miss a day of work (and likely a day of being paid) to participate in the study. Her empathy led to her respect for both the patient and the sample. For Slote, empathy and respect are deeply connected; there is only respect where there is empathy and vice versa (2007: 57). But any discussion of touch, like any discussion of care, also has to grapple with its complexities and contradictions.

WHAT HAPPENS IN TOUCH?

Barad warns that "Touch is never pure or innocent" (2012: 215). Puig de la Bellacasa reminds us that "touch opens us to hurt, to the (potential) violence of contact" (2017: 99). She cites Thomas Dumm (2008), "who reminds us that touch comes from the Italian *toccare*, 'to strike, to hit'" (Puig de la Bellacasa, 2017: 99). The relationship between touch, care and violence is woven together in this etymology. This ambivalence of touch, and the violence it lends itself to, makes it difficult to think with in relation to my research. But as Haraway would say, we must "stay with the trouble" (2016). Inside the laboratory, the bacteria and the cells could not easily refuse touch, though I have argued that the ways in which they were cared for complicates simplistic narratives of exploitation, domination and annihilation. As for human-human contact, touch – and the inability to be touched by what is touched because of the requirement in scientific research for detached touch – opens itself up to hurt and violence. In this case, I would like to weave connections to structural violence.

Following Barad, "So much happens in a touch: an infinity of others – other beings, other spaces, other times – are aroused" (2012: 206). In the moment of touching the patient samples from the bronchoscopies, Leigh touched a person who was worlds apart from her, although their worlds did meet and were done and undone for a split second. She touched a life that she was not allowed to be immersed in and a socioeconomic gap that would always haunt her. In that same moment, the patient touched enormous inequities in the burden of disease, medical systems that historically – and continually, some would argue[54] – hurt and take advantage of black and brown bodies and deep structural inequalities that perpetuated his position (see Ross, 2010). The lab and the outside world are collapsed and brought together for a moment, an eternal moment in Leigh's career as it was one that *changed everything*, as she alluded to in her interview.

Each of my participants touched and connected their tentacles to the world from which their samples came. This is the basis of Chapter 5. While Chapter 5 moves beyond the laboratory, beyond the science, this chapter highlights the connected touching from the hood. Marina told me that when she received the lung cells used in her research, she thought about the human from whom they came. Sitting next to her in the BSL3, with patient samples in front of us, she said this was especially the case if there were "black things" inside the sample because that meant the person smoked. "And so, I think about that," she said. But not all of my participants worked with human samples, and in two cases the boundaries between human and animal, lab and outside lab, collapsed as my participants touched and connected with the more than human.

I met Alison one morning after she and her students had taken a trip to a farm to collect blood samples from cows. She was horrified by the conditions in which the cows were living. Showing me photos that she took of the farm, she pointed to the ground in one of the photos. She explained that it was supposed to be concrete, but was instead covered in cow dung that had not been cleared. She then showed me a photo of a sad-looking cow and said that she needed to speak to someone about it. I did not follow up whether Alison spoke to anyone

[54] See Laurel Baldwin-Ragaven, Leslie London & Jeanelle De Gruchy, 1999; Adriana Petryna, Andrew Lakoff & Arthur Kleinman, 2006; Adriana Petryna, 2009; Helen Tilley, 2011; Kristin Peterson, 2014; and Amit Prasad, 2014.

about the conditions the cows were living under and knowing her, I am sure that she did, but I do think that this points to the ways in which my participants were touched by what they did.

They were not only touched by what they did, but they knew that what they did had an impact outside the lab. In other words, that what they did – what they touched – would touch others. Leigh's research would help to determine whether TB treatment could be shortened, Alison's research was directly implicated in the management of lions and Emily explained her impact in much broader terms. She had worked on a diagnostic test for rhinos and explained that if the rhinos tested positive for TB, the park went under quarantine. This meant that animals were not allowed to be translocated, and that had consequences for economics, conservation, poaching, tourism, and people's livelihoods. Referring to this, Emily said, "The pressure, the expectation, it's not a degree where you're like… There's the social aspect of it where your results, your being careful in the lab, your interpretation of your results, it has a huge [impact]." In this sense, to touch is to be touched and to touch many others. Each of my participants' research had relevance, bridging the translational gap in the sciences.

THE IMPORTANCE OF TOUCH AND CONNECTION: SOME THOUGHTS

In Chapter 3, I argued that scientific research was personal and was situated very close to the bodies, minds and hearts of my participants. Building on that argument, this chapter – Chapter 4 – described how that intimacy made it very difficult for my participants to touch without being touched in some way or another. Each of my participants was deeply entangled *with* the other, whether the other was human, sample, cell, bacteria or animal. In this chapter, I argued that my participants became *with* the subject-objects of their research, in a very involved and fleshy way. Furthermore, I argued that touch revealed the care on the part of my participants. Touch – in both the physical sense and the sense of coming together, a breaking or blurring of boundaries – evoked care. I used the concept of *porous boundaries* to speak to this movement and flow. This helped to conceptualise what I had observed – a laboratory that was *in touch* with the world. The boundaries between the laboratory and the world beyond it were porous despite the kind of boundedness that scientific research often requires. I played with the idea of touch, particularly because being accused of being "out of

touch" is about being far removed, lacking understanding, not raising "the question of 'what it is to be "with" the other'" (Despret, 2004: 128). This was anything but what I had observed and what I had heard from my participants. Speaking about care, Puig de la Bellacasa writes, "Its lack undoes, allows unravelling" (2017: 1). This is significant in relation to the scientific research of my participants because their care, their touch and being touched, brought the space of the lab and the "real world" together rather than unravelled or separated them. It wove them. The next chapter extends upon this connection.

Puig de la Bellacasa writes that "touch is world-making" (2017: 113). That particular worlds are made through touch is significant. We need to create worlds that are in touch, that collapse boundaries, that challenge binaries, that overcome distances, that connect disconnections. Following the argument for relevance that centred the discussion of decolonising science that came from the students, that is what a decolonised science does. Specifically, that is what it does when it is connected to the world in which it exists. The following chapter, through connecting the laboratory and the world outside, paves the way for the exploration of this discussion in the final chapter.

CHAPTER 5 – WHAT DO SCIENTISTS CARE ABOUT? WHAT MATTERS?

I presented a paper at the 2017 American Anthropology Association (AAA) annual conference for a panel titled *What Matters to Laboratory Scientists?* What I felt was absent in the other presentations was the kind of ethnography that propels you into the lifeworlds of scientists and gives you *a feel* for those worlds[55]. While these presentations were all based on ethnographic research, I struggled to find the voices of the scientists. In this chapter, I aim to foreground the voices of my participants to show a glimpse of what mattered to them. What mattered to them is what they cared about. I rely heavily on their own words, quoting them at length, to ensure they tell their stories as much as possible. These kinds of stories are often not told because there is no space for them in job performance reviews, they do not make their way into scientific journals and they are not measured as part of scientific research outputs. This chapter dedicates space to these stories.

While I have discussed how scientists cared about bacteria, cells, mice, lions and rhinos, this chapter moves beyond the laboratory, showing what else mattered to my participants and how their care extended far beyond "their niche or current experiment," as the head of the division wrote in his email that I discussed in Chapter 2. My participants exemplified scientists who cared deeply about things very different to what science demanded. Thinking through what was important to these scientists can help to think through ways of decolonising the institution of science by interrogating what matters. In other words, what would it mean if what matters to scientists matters to science? What would science that is relevant to scientists look like? I argue that my participants were already decolonial scientists, "doing" decolonisation through their weaving of the laboratory with the world outside. Unpacking the relationship between care and proximity, this chapter shows how care extended far beyond the enclosed space of the laboratory, making it a valuable quality of a science that aims to be

[55] I draw on Barbara McClintock's "feeling for the organism," that I have referred to in a few places in this thesis. Pivoting off the argument in Chapter 4, it refers to the kind of knowing that occurs through a deep sense of relationality and identification.

impactful. Impactful science is science that breaks the science/society binary because of its relevance outside of the laboratory.

While I have drawn on Isabelle Stengers (2018) throughout this thesis, this chapter challenges her conceptualisation of scientists. One of the things that led me to research with scientists in the first place was the disparity between what I read about them and what I had observed through my encounters with them. This might appear like a major generalisation, but it is in response to a major generalisation about scientists that both Stengers (2018) and Green (2020) make. In *Another Science is Possible*, Stengers asks the question, "What defines the scientific vocation, what stuff is a real researcher made of?" (2018: 25). This is an important question because it asks: What matters in science? What matters in research? What does it take to be a "good" scientist or a "real" researcher? In Stengers' argument, having the "right stuff" means "having faith that what a scientific question doesn't make count, doesn't count" (2018: 36). Having the "right stuff" means accepting "that questions which concern the wider world… should be globally defined as 'nonscientific'" (2018: 115) and "a waste of time" (2018: 38). This leads Stengers to argue that scientists are being trained to be "sleepwalkers" (2018). In this argument, they are purposefully blinded to the bigger picture, ignoring the consequences of scientific research beyond the laboratory and ignoring other matters of concern. Science is dependent on its sleepwalker scientists, according to Stengers (2018). She argues "that the only possibility of 'saving research' goes by way of waking up the sleepwalkers" (2018: 43). For Stengers (2018), this will only happen if scientists interrogate what the "right stuff" of research and researchers are. This is all about interrogating what matters and what should matter.

My participants challenged this conception of scientists as sleepwalkers. They were already breaking with what Stengers has referred to as the "ivory tower" of academic science (2018: 114). The "right stuff" to my participants was not necessarily the "right stuff" to their research, to their career trajectory, or the "right stuff" of science, as it stands. This leads me to argue that there is a disconnect between what is expected of scientists on paper, and what happens in the flesh, in real life, when human beings sit down in a laboratory, with their experiences, their feelings, their views, their perspectives, their outlooks. Maria Puig de la

Bellacasa writes, "The picture on the ground is always more fuzzy" (2017: 10)[56]. Scientists challenge what we think about them, or at least, what Stengers' thinks about them. With this ethnography, it becomes clear that my argument for decolonising science that takes shape in the next chapter is about centring and valuing things that I observed to already exist in scientific research. Lesley Le Grange writes, "decolonisation should be driven by the positive power of *potentia* and not the negative power of *potestas*… Decolonisation is not something that should be imposed because then it would be driven by *potestas*" (2019: 42). This chapter highlights the ways in which decolonisation in science could be shaped by values and actions that already exist, that can function in ways that do not need to be imposed from the outside. To weave that argument together first requires showing parts of the *salaula* tapestry that reflect what my participants cared about.

"IT'S VERY HARD NOT TO GET EMOTIONALLY INVOLVED": SCIENCE IS PERSONAL

As I have argued in each of the previous chapters, scientific research is deeply personal. Each of my participants cared deeply about the work they did and had a deep emotional connection to their research. Their research projects mattered to them, not in some abstract sense, but in a deeply personal way. Leigh's response below reflects this emotional investment:

> My contract is yearly, so I don't know if someone else might take it over, take the reins over. Which is often really sad in like your science because sometimes you don't get to see the full end of your work that you've been working on just because you move on, or your contract isn't renewed or whatever… It's very hard to hand off. I've always really struggled with that. Like even my PhD, I came up with all these biomarkers for abalone, like abalone diseases and things. I worked really hard on developing them, validating them, making sure they were real. And so now they're testing it on the farms and I just had to like hand off the stuff that was like my five-year project that I worked so hard for. And hand it off onto someone else. And it's really difficult to do. And it was quite heart-breaking, but you have to get used to it. Like it shouldn't be personal. But it's very hard

[56] Interestingly, "fuzzy logic" is a model with which to account for the messiness – the imprecision and uncertainty – in biomedical research (see, for example, Torres & Nieto, 2006).

> not to get emotionally involved. I find if a scientist says they're not invested emotionally in their project they're probably lying. You have to be.

Grace expressed this emotional investment when she explained her research with parkin – a protein inside the macrophage that is involved in helping the macrophage get rid of the bacteria:

> I started with it [parkin] during my honours and continued through my masters. Now, it's translating to my PhD. And I've learnt a lot about the protein… so, it's also a journey for me. All through my honours, I followed the protein, I've learnt about it. I think now it's personal to me… So, parkin is just something I'm getting attached to.

Grace described learning about and coming to know the protein. Her research involved following the protein and observing its processes over time, making significant connections to the theme of movement. But important here, is how her involvement with the protein translated into an attachment that entangled her with her scientific research in a deeply personal way. I recall Emily saying that "everybody's heart" was in the research, which reminded me of Hilary Rose's article "Hand, Brain, and Heart" (1983). In the article, Rose urges for the inclusion of the "heart" to counteract the "abstract and depersonalized" (1983: 84) nature of scientific production that hides what is fundamentally "the labor of love" (1983: 83). Natasha Myers also wrote about her scientist participants' "profound sense of investment" that resulted in a "product of labor and love" (2008: 188). These examples that echo what I observed and heard from my participants demonstrate the very personal connection and entanglement that scientists have with their research. This extends the discussion of entanglement that was the focus of the previous chapter. This chapter, however, moves beyond the laboratory to show that their scientific research was not the only thing that my participants cared about.

"OH MY GOD, I DON'T HAVE ENERGY FOR THAT!": PUBLISH, PUBLISH, PUBLISH

"Publish or perish," Leigh reminded me in a discussion we were having in front of the laminar flow cabinet. She held up a patient sputum sample in her hands inside the hood. "This is such

a nice one," she said looking at it. After seeing many of her samples, my amateur eyes could tell that she was holding a good sample of sputum based on its clear colour and perfectly snotty consistency. I remembered her saying about the sputum, "It's amazing what you can get used to." I too got used to seeing sputum. While she followed the protocol with the patient's sputum, we spoke about what being a good scientist meant in the world of science. "To be a good scientist you have to publish," Leigh said, "That's the only way you are recognised." She told me about a female scientist in the division who "should be a PI" but was not one because "she doesn't look good on paper." "She is a good scientist," Leigh explained, but she puts a lot of "time and effort" into her research. She "takes her time, figures things out." This example described how time prolongs work and therefore publishing. Comparatively, I was told about a PI who only cared about "low-hanging fruits." According to Leigh, low-hanging fruits in this context meant doing "easy stuff" that was guaranteed to get published. This difference highlights what is valued in science, namely, quick research that leads to publications. This weaves connections to my discussion of the tensions between technoscientific time and "unproductive" slower-paced care time that I explored in Chapter 1. For Stengers (2018), this obsession with fast publication gets in the way of research that matters. This connects to the email from the head of the division when he wrote, "All to [sic] often we are measured on our outputs and not whether they impact – do we care?" This brings to the foreground whether scientists care and what it is they care about.

For my participants, publishing – the measure of success and scientific "excellence" – did not matter as much as it mattered in the world of science. In an interview with Grace, she explained:

> They just want to see your paper's been published. So, I wrote on my, like I have a piece of paper, I just write things, and I wrote there… I know that's probably not accurate in the science world, but I was like *'Publishing a paper, a scientific article, doesn't directly correlate with success.'* I was just saying that to myself because that's what the world, that's what the scientific world counts. That's what they see. They score you based on how many articles you publish, how many citations you've gotten. But I don't want to see that… So, it's also something I've been thinking about. Would I be satisfied just being a teacher? Like not publishing articles. Just being a teacher. Would I be satisfied if I could

> say I trained a certain amount of people? Would that give me satisfaction? And I think I was quite happy. I also want to publish papers and all that, but I also enjoy the satisfaction from training somebody and then the person is now being, is now able to stand independently and conduct their own research, they understand their research. I'm very particular about understanding. *Why* are you doing [what you are doing]? Not just being able to do it. Like the reasoning behind it. Why do you do it? So, I think that's what I want to count as success.

Grace cared about understanding, as she explained, she was "very particular about understanding." This connects to her discussion of being particular and taking her time that I explored in Chapter 1. This was something that slowed her down because it worked in contrast to the fast pace of productive technoscientific time. But what mattered in the world of science did not necessarily matter to Grace. Grace described what science cared about – "what the scientific world counts," – which is the number of publications and citations. That is how a scientist is measured or "scored." For Grace, however, although publishing was a welcomed result, it did not define success. She viewed success as teaching and helping others understand science and conduct their own scientific research.

Relatedly, publications were not the priority for Emily either:

> And I don't also have the skin for fights, fights that will not really contribute to my life or even the betterment of humanity. Let's say if you're fighting about publication – because that's what goes on in research. It's about putting who and who on the paper and who writes it first. No no, I do not have time for that. I just feel there are more important things in this life… I mean I'm not going to fight about who wrote the paper first, because I don't have the skin to fight. If you remove me from a paper even if as much as I also tried to put in, I contributed, I'm one of the people who would not say anything. I'm like "cool."

Emily spoke to the highly competitive and self-preserving nature of the scientific discipline. A world that she did not want to be a part of. A scientist's career depends on publications. Emily explained:

> The list of publications comes in with your NRF [National Research Foundation] application. Those are questions they ask you. So, if you are going to be in academia, you need to keep that going because otherwise you won't be able to get funding. It's a whole cycle. Oh my God, I don't have energy for that!

Emily cared about different things. She continued:

> The impact for me is the thing. It means more to me… I'd rather do the public engagement. Like involve the public or the community and do the awareness of TB or whatever it is than write a scientific paper that can put a name to me scientifically and the community won't even read it. I mean who reads it?! It stays in academia! It's all scientific and only scientists will understand it and it just circulates there and there's like no relationship here. So, for me, that's where I want to see my science go. I want it to be impactful. So, I don't have energy for this… Because I mean, our group, I can tell you who is so concerned about publications and whatnot. Because then that's all they do. They're always just looking for opportunities in that way. And the thing is, even the way they relate to the group, the social aspect of it, you see it from that. I'm sorry, they are selfish people. Because they can do anything to get that publication. They will do anything to get to that conference.

Creating impactful science and meaningful *relationships* with the community was more important to Emily than creating science that was only relevant to scientists. "Community" here referred to people outside the academy and the laboratory, particularly people who could benefit from the products and findings of scientific research. Emily understood that she was a TB scientist and, therefore, had the potential to educate and provide TB awareness in what the World Health Organization calls a "high TB burden country" (WHO, 2021: 34). This mattered more to her than publishing. Emily wanted her science to have a place outside of the laboratory, within the community. She pointed out what Stengers has referred to as the *insularity* of science (2018: 50) whereby science is only relevant to other scientists. Scientific outputs are only read and circulated within the scientific community. As Emily asserted, "there's… no relationship" between scientists and the public with this kind of science. I have shown in Chapter 2 that relationships are a central element of care and argued that a caring science is a *relational* science – one that builds relationships as well as maintains them.

Emily – like most of my participants – wanted to move science beyond the ivory tower, to ensure it had relationships with the community beyond the laboratory. She raised a similar argument to Alison about the selfishness of science when it prioritises publications and conference presentations over conducting science that is in communication with the community. Science that is *with the community* would be science of salience to people outside of these insular spaces – people with other concerns[57]. This tension that Emily raised – a tension also raised by the students in the Science Faculty Engagement meeting that is discussed in Chapter 6 – was precisely the tension between science for other scientists and science for the community[58]. Again, many of the discussions constellate around this tension because it is precisely a discussion about care and what or who science cares about. Emily's response brought to the foreground the competitive, selfish, greedy and self-preserving culture of science.

COLLABORATION VS THE LONE RANGER: COMPETITION, GREED, SELFISHNESS, CARE FOR CAREERS

In an interview with Leigh, she said:

> We need more collaborations internationally to answer these questions. I think that's a big problem in science at the moment… everyone operates independently because you need the grant and I'm trying to get the grant over from you, so I'm not going to tell you what I'm working on. Whereas if we want to solve the world's problems then everybody needs to start working together. That's what everyone says we're doing, but that's not the case… it's competition. That's what happens in competition. And that's how funding models work. You're in competition with everyone else, so you need to be better. You need to keep your ideas to yourself as much as possible until you're ready to publish. How is that conducive to collaborations? It's not.

[57] I thank Amber Abrams for the term "salience," a concept that she uses to describe the importance of science that is applicable, relevant and beneficial to people outside of the laboratory and academy (personal communication, 2021).

[58] In the case of that meeting, and within the context of decolonising science in South Africa, "the community" refers to the African community, or African people – as it was implied by the students (see Chapter 6).

Leigh highlighted how the importance of collaboration to successfully tackle scientific problems that would help the world was met with the highly competitive culture of science. This "lone ranger" (Nyamnjoh, 2012, 2015) scientific culture is counterintuitive to real collaboration because scientists need to fight for funding to continue their research and get publications to remain in the game, both of which require operating independently to get ahead of their colleagues. This also provides a tangible example of the dichotomies between scientific research and an ethics of care that I discussed in Chapter 2 with its prioritisation of self rather than relationships. But, as I continue to argue, my participants challenged this culture through their care. In this case, it was exemplified through their care for their colleagues.

Marina took off a whole day to help another scientist conduct some tests, so she could finish her PhD. Leigh explained that she was *careful* not to tramp on another scientist's toes since they were both in the same research field. She had a lot of respect for this scientist and avoided any exploratory projects that might encroach on her field. She said that she was probably "too nice" and "to publish, you can't be nice." Leigh explained that scientists in the division worked on certain projects and there was a sense of territory around certain research areas. Leigh found an alternative branch of research so that she could still stimulate her scientific curiosity and not trample on any toes. Fellow scientists mattered more to Leigh than publications.

This ran counter to the "selfishness" of the culture of science that Alison discussed. Alison explained, "And also people are so selfish, you know they don't want to tell each other about grant applications. I mean they want to be a big fish in a small pool." She reflected on what this meant for careers that are defined by service, saying, "And I actually said that the irony of being in a medical faculty, your life is dedicated to service of others, and yet there's so much selfishness." Emily also spoke to this selfishness. Explaining the order of authorship on scientific publications, she said:

> Because I write, because, of course, I go through the hard work, I'm the first. The middle people don't really sometimes count. Not that they don't count, but who really cares about the middle people?… It's the last people and the first people… The last is the senior.

> That's where the PI comes in… The middle people are all those people who contributed… So, I'm thinking, how does this person come in? ... The paper has to go through co-authors for input and most of them only found out when I sent it to them that… they are even on a paper. Then they read, at least they gave me something, but I was just wondering, like really?! This is a game!... But they are also greedy! They're bringing in the big people for the sake of their own benefit. Come on, everybody is greedy… that is why I don't have the skin for it.

"Selfish" is a significant word in relation to the theory on care, because it prioritises the "self" over relationships. Alison's main argument – discussed in Chapter 2 – was that laboratory scientists' care often did not extend beyond the laboratory and that there was not a lot of genuine care for human beings. "So that is a selfish thing because even though you're saying you care about this, you only care about that for what? Is it really to benefit the human at the end of the day or is it about your career trajectory or about your career success and, in turn, also sort of helps humans?" Alison asked. Specifically, Alison's argument highlighted that care was about moving beyond the laboratory to build relationships with communities through community engagement and helping people through teaching. Importantly, caring was about time *not* spent in the lab, time that punctured laboratory time. It was about giving time to things that benefitted others more than the individual scientist because they were things that did not necessarily support career success or fit in neatly with the fast-paced rhythm of scientific career trajectories. That was what care meant to Alison, and that was exactly what she cared about. Alison was involved in various community engagement and personal projects with the goal of helping and empowering others, which I elaborate on in detail towards the second half of this chapter (see section "Helping Others Beyond the Lab").

Science is beginning to make these things "count," as Grace highlighted:

> So, in the department there is a lot of force going towards social initiatives… it's encouraging that I can say that there was this high school student or high school learner came into the lab and I was able to explain our research, I was able to teach him or train him. So now they are beginning to count that.

This push for social engagement shows the beginnings of the institutionalisation of care in the sense that care involves cultivating relationalities that dissolve the science/society, lab/real world binaries. But on the other hand, Grace argued that being involved in outreach did not necessarily mean a scientist cared:

> So, I don't know who or how it came about, but now the department has just been pushing [for social engagement work]. So, it's quite, it's mixed feelings for me. Now they appreciate it more. Now people want to do it because you see they appreciate it. Not necessarily because that's what they really want to do. People are just doing it… So, it doesn't really sit well with me. I wouldn't like that to be the reason why you do it. Not because you want to get something out of it, just because it's going to score you a point. So, I don't really appreciate that.

This echoes some of what Alison was referring to when she asked, "Is it really to benefit the human at the end of the day or is it about your career trajectory or about your career success and, in turn, also sort of helps humans?" This brings the discussion back to interrogating the "self" in science. But not all scientists are interested in community engagement, even if it does look good on paper.

"I'M STRONG IN THE LAB": BASIC SCIENCE MATTERS

"I'm strong inside the lab," Leigh said in our discussion about science and public engagement, "Science engagement is not everyone's thing." Leigh, who also attended my presentation, told me about how public engagement had become a huge part of funding applications. "There is a big demand for it," Leigh explained. The section for engagement was bigger than the section on scientific research. Leigh believed that this took the focus away from science. She was not saying that it was not important, but that "it should not be the job of the basic scientist." For Leigh, the job of the basic scientist was *science* and the push for public

engagement seemed to get in the way of that. Leigh was very concerned about this and commented that it was not like this “overseas”[59].

The implications of not being involved in community engagement as not caring was striking a chord in the division, particularly for those who attended the presentation. Leigh was, however, directly involved in the art exhibition that I curated at an art gallery in Cape Town. Not only were a series of her science images exhibited (see Image 3), but she was actively involved in the organisation of the exhibition and she curated displays with detailed descriptions that brought the public closer to understanding the world of TB science (see Images 7-10). Leigh was also present at the exhibition events to engage with visitors who attended the exhibition.

Image 7: Exhibition display of Mycobacteria Growth Indicator Tubes (MGITs). These tubes are used to grow TB bacteria from human and animal samples. The tube contains liquid media and a special fluorescent indicator that detects when the bacteria starts to grow and multiply. This process is monitored by a machine that flashes “positive” when it detects growth inside a tube. Photo courtesy of Cliff Shain.

[59] It was pointed out to me by Amber Abrams (2021, personal communication) that the history of colonisation makes funders more sensitive to do research in places where people are “of colour” and, therefore, community or public engagement seems to be pushed harder in lower-income, previously colonised settings with the aim of “helping.”

Image 8: Exhibition display of the GeneXpert MTB/RIF. TB is diagnosed in this plastic cartridge in two hours. Inside the cartridge, bacterial DNA from a sample is extracted and copied in order to detect the presence of TB as well as resistance to the TB drug Rifampicin. Photo courtesy of Cliff Shain.

Image 9: Exhibition display of a microscope. The microscope is commonly used in TB science to observe ZN stains in order to detect and diagnose TB, as seen in Images 1, 2 & 6. Photo courtesy of Cliff Shain.

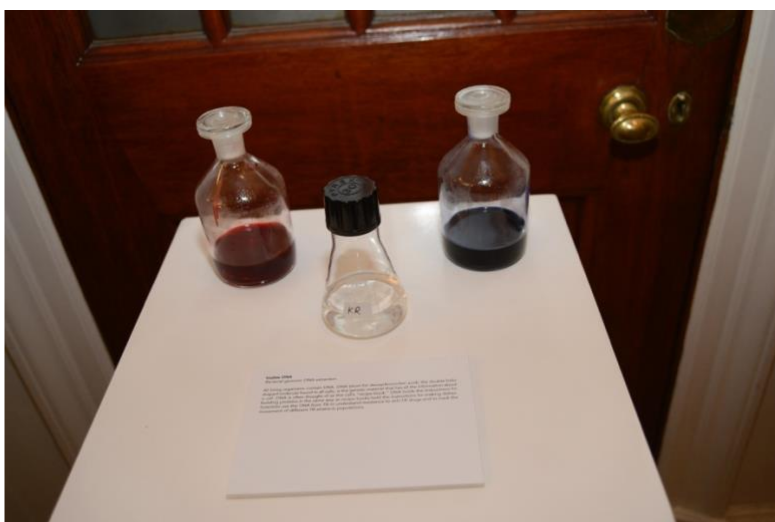

Image 10: Exhibition display of liquids in bottles to represent the DNA extraction process. This display aimed to visualise bacterial genomic DNA extraction. Scientists use the DNA from TB for many purposes, such as to understand resistance to TB drugs as well as to track the movement of different TB strains in populations. Photo courtesy of Cliff Shain.

Caring takes many forms. Leigh's work responded directly to the head of division's thinking around producing caring research rather than bringing in care after the fact to justify the research. Her research could help patients shorten their TB treatment cycles from six months to four months. This is extremely significant, especially when juxtaposed against the lived experiences of TB patients and their lengthy treatment protocols, such as those described in the ethnographic accounts of Kate Abney (2014, 2020). If caring – as it is being framed in this thesis following Alison's argument – has to do with moving beyond the immediate proximity of the laboratory and breaking the science/society, lab/outside-world binary, Leigh did that in many ways. Community engagement was not the only way scientists care beyond the laboratory. As I discussed in Chapter 4, Leigh reported all of her results to the nurses in the clinic even though it was not part of her protocol and Leigh was in touch with the world of the patients involved in the clinical trial and from whom she received sputum samples. She spoke about how her experience in the clinic with the patients made her "a better, more careful researcher." Her care extended even further, to the environment.

THE ENVIRONMENT MATTERS

Leigh also cared deeply about the environment. One of my first conversations when I started doing fieldwork with her was about the amount of waste produced inside the P3. Working with *Mtb* safely involved putting on various layers. By the time we entered the P3, we were covered in items that would be disposed of a few hours later, and the next day we would begin the process again. To add to this, each experiment and protocol inside the laboratory produced a huge amount of waste. "Hazardous waste" signs were written on various waste bags, waste boxes and dustbins. Each day the waste would pile up. Brand new tools used only once, aliquots, culture flasks, Petri dishes and plastic bags were thrown away by the hundreds on a daily basis.

Leigh was extremely conscious of the waste produced in the name of science. "But what can you do?" she asked. To "make up for it" she tried to be as waste-free in her own life. Climate change was a big concern for her, and she often raised it in conversation. She was worried about the growing lack of belief in climate science – at the height of Trumpism, when my fieldwork was being conducted – and the consequent climate change denialists. But Leigh

was not just concerned. She cared. As I outlined in Chapter 2, the primary difference between concern and care lies in the doing, the action. In response to her care for the environment and her worry over the waste produced in the laboratory, Leigh reduced the amount and volume of the cultures she used to get the protein – the one that she used to "wake up" the persisters – because too much throwing away of culture (and hence, the plastic bottles in which the cultures are kept) occurred. Although a seemingly small and insignificant act, this would make a huge difference in the laboratory waste that Leigh would produce over time. This small shift in her protocol was a disruptive action, because she made a calculated decision to intervene in the production of waste for the betterment of the planet.

Puig de la Bellacasa writes, "I am thinking care itself as a critically *disruptive doing* that can open to 'as well as possible' reconfigurations engaged with troubled presents" (2017: 12, emphasis added). For Leigh, care was the "disruptive doing" of reducing the disposal of culture flasks to open up to what she thought was "as well as possible" reconfigurations considering the "troubled presents" of the environmental crisis we are in. Her "as well as possible" reconfigurations hoped for a different environmental future and considered her role in it. Leigh's actions showed her deep understanding of interdependency, a central element of care that was discussed in Chapter 2. Leigh's caring was holarchical because she understood how every part connects to the whole, that the lives of humans, more than humans and the planet are entwined. Her proximity of care, therefore, extended far beyond humans to encompass the planet. As Puig de la Bellacasa notes, "personal ethico-political practices of change need to be also rethought as collective" (2017: 139). Leigh's personal scientific practice, whether it was reporting her results to the nurses or reducing the number of culture flasks that she disposed of, showed her commitment to the collective. In this, and in the many other ways I have described both here and in the previous chapter, Leigh exemplified that a scientist can be extremely dedicated to their science, but still not be a sleepwalking scientist. Leigh struck the balance between caring for what is inside the laboratory at the same time as caring for what is beyond it.

HELPING OTHERS BEYOND THE LAB

All of my participants loved teaching and sharing information and knowledge. Grace wanted to make YouTube videos so that she could teach basic science and make it accessible to everyone. In our interview, Grace spoke about her passion for teaching:

> I generally enjoy, like I enjoy teaching. In undergrad, I wanted to be a lecturer. So, teaching and lecturing, that's what made sense to me. And then now I got into research, I want to teach research… Like every time I do something, like I've done an infection protocol, I don't know how many times I've done it, but like every time I do it, I find an easier way to do it… Whereas some other people just want to follow a protocol, this is what the protocol says and just do it like that, they *don't care* about trying to make it better… Like I've explained the process to somebody… and he was like, 'Is there no protocol? Can't you just give me the protocol and I'll just follow it through?' But then I wanted to teach you *why*, make you understand why you are doing this so you can also think about what you could do to improve it.

Grace cared about improving protocols. She also cared about passing on her knowledge so that she could help other scientists do things better. This countered the competitive culture of science. Rather than being selfish and keeping things to herself so that only she benefitted from the improvement of the protocol and got ahead of her colleagues, Grace shared that there were better ways to do things. Grace cared about helping people. She was also part of the art exhibition as well as the school engagement project in which I was involved. She had a huge passion for sharing her knowledge, explaining scientific research, talking about science and getting involved with projects that allowed her to do so. This pushed her care well beyond the scientific research that she conducted inside the laboratory.

Helping other people was also one of Alison's main goals. She asked someone to be her mentor who exhibited a philosophy that was very important to her. In our interview, she told me about it:

> I have actually recently asked someone to be my mentor… And I said to my husband that I love this man because when I've heard him speak, you walk away inspired. He sort of

> embodies my family's life philosophy… And his life philosophy is about living a significant life. And he says you live a significant life when you can help others succeed. Only then can you have a significant life. And that makes you happy. So, it's a by-product of helping other people.

This philosophy was about service and deep caring for others. It was also about happiness achieved through the helping of others rather than the individual. It was about collective benefit rather than selfishness. This was fundamental to Alison’s work as a scientist. Alison explained:

> Even the work that I'm doing, my postdoc. My entire proposal was written in order for skills transfer, for capacity development. Because that's what I want to facilitate. I don't have to be the person at the front. I don't even have to be the one getting the grant to do it. As long as that is happening, that's fine. But you know, I love a lot of things. So, I become passionate about whatever is put in front of me. Because again, it’s your choice to have passion or not. But yeah, I love working with people. I'm not an office worker. Like it gets depressing if I have to come into the lab every day and just do the same thing.

It was very clear that Alison cared about being of service. This was also apparent in how she mentored young women scientists:

> I organise the mentorship programme. And that's our honours students that come in and then they’re paired with an older student. And then if they have issues, they have to talk to me. But what I've done beyond that is… because, like I said to you… supervision is a holistic thing. I don't believe you only supervise someone in the lab. You have to talk about those intricate personal things that might be affecting their work in the lab or might be affecting how they communicate and all of those things. So, what I did with my two honours students was, we had a discussion, I said come here, tell me your strengths and tell me your weaknesses and tell me, you know, how you going to address those weaknesses. And tell me about what you wanted to be when you grew up, tell me about where do you see yourself. And we really got to this point of insecurity and not feeling worthy and imposter syndrome. And, you know, things like that which I think are constant. Doesn't matter who the woman is, doesn't matter what the field is, it's about

> overcoming that. So, I have a lot of conversations with women about that. Getting over that insecurity, and they are at different levels

Alison cared about helping these women feel empowered. This was not a superficial venture. Her mentorship brought the personal lives of her students to the foreground to better help them succeed. This also showed the cultivation of deeply personal and caring relationships. Alison's care and desire to help people extended beyond the division too. She was on the task team for drafting the faculty's transformation charter, which addressed discrimination and transformation. She also facilitated conversations on parts of the charter. She was an active member of the organisation SAWISE (South African Women in Science and Engineering). She was involved in various Postgraduate Council events, such as speaking at a PhD forum about what her PhD journey was like, her challenges and what advice she would give. She also developed "Cuppa Convos" to create spaces where women academics could speak about issues that were relevant to them:

> The Cuppa Convos was my brainchild, and I just thought that it's a space for women to come together and voice their insecurities and say, 'I don't know what I'm doing, what did you do?' And for the older women to say, 'these are the mistakes I've made along the road.' Because SAWISE is supposed to pull woman together and it is supposed to be *I support you, you support me*. Ideally what you would have is a group of women or female scientists in the Cape Town area making smaller connections, smaller groups, and if one has to work late you can be like, you know I know you've got kids, you live in my area, please help me with my kids. Even things like that for single women. We need to have that kind of network.

Alison was involved in numerous projects, she was part of three different research groups, she worked with two honours students whom she trained intensively – she sat daily with one of them, went through their thesis and gave them all the help that they needed. She was involved in many science communication projects as well as science engagement projects, she ran the mentorship programme and she mentored a young scientist in another research group on a personal level. As discussed, she was heavily involved in creating spaces where women could network as well as support each other with domestic responsibilities such as

caring for children. She had huge vision, as she articulated, "I've shifted that focus away from talking about the problem and shifted it into the vision. What can we do? Solving small things at a time." It was not just her immediate scientific research project that she cared about, there were multiple levels of care that extended beyond the laboratory. I began this chapter with Stengers' (2018) argument that scientists are sleepwalkers who are not concerned with anything beyond the scope of their scientific research project, anything deemed to interfere with the scientific problems at hand. Alison (and this goes for all of my participants) showed that this is not an accurate representation of scientists. I continue this argument in the following section, with an example of how my participants were enacting real change.

(FOREIGN) AFRICAN STUDENTS MATTER

When I asked Grace, who was from Nigeria, whether she had experienced any gendered discrimination or felt undermined because she was a woman, she explained that she had received more discrimination because of her nationality:

> I don't want to label myself as a disadvantaged student, but I've definitely suffered being an international student. Bursary applications, yeah, it's been hectic. Even though I know I can do as much work as you want me to. I can work as hard as a local student. But then just because I am a foreign student, I do not even get the opportunity to prove myself. So, I don't want to have to beg for funding, or like ask. I want my work to be able to provide funding. I want to be able to work hard and say my work made me get this. Not because I have no other option, I wasn't given a chance… That's usually what happens. You apply for this funding and you don't get it. One of the many reasons is because you're a foreign student. It's allocated to local students. And then I have to go personally meet someone, 'okay can you please fund me.' So, I don't want to have to ask. Sometimes I feel bad. I work hard. I know I work hard. I just want my work to speak for itself.

Being a foreign African student was not easy and posed another set of challenges[60]. Foreign African students occupy a liminal position in the South African context because they are not "South African enough" to receive South African funding or opportunities afforded to South Africans, but not "European or American enough" to qualify for international funding and opportunities. They battle visa applications, residence placements, funding opportunities and a sense of belonging that is beyond the scope of this thesis. The lived experience that Emily details below showed the extreme difficulty of being a foreign African student at a South African university. Grace's experience outlined above touches the surface of how race figures in relation to nation, but by no means does justice to this topic. Emily, who is originally from Zambia, recounted her experience of starting her PhD at the division:

> Coming here, I'm like, okay first I need to figure out how to communicate because I don't know if they understand. I don't know how it goes. It was a very difficult time in my life. Difficult. So many things, like the different cultures. Different how they see things. And most of our division, if you coming in for the first time, I don't know, for me it was a very unfriendly division. People really are serious about publishing… Now imagine [how weird it was] for me, where you can actually count the number of black people. And they just thought I'm from Limpopo. And I'm like, no, not everybody's from Limpopo[61]… So, it was so difficult. I couldn't relate with anybody. Like who could actually understand where I'm coming from? And because everybody just assumes you should be fine. Or if you're new, you better up your game, literally. I had to do that. So then imagine mentally, socially, everything. It was crazy. It was too much. I was miserable. I didn't know anybody.

Emily went to two separate South African universities before starting her PhD at the division. Both had structures for international students and both had housing on campus. "You're

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[60] "Foreign African student" is used here to refer to students from other African countries who live and study in South Africa. I do not use "international" because, as will be shown below, that word implies a different kind of foreign student studying in South Africa – specifically a white Euro-American one and all of the privileges and opportunities that come with that. Whereas this section, through the experiences of two of my participants, shows some of the challenges that divide African students, Chapter 6 shows how students used "African" in ways that united students from various African countries in the movement for decolonising the African university.

[61] Limpopo is one of South Africa's nine provinces. Apartheid imposed geosocial spacing according to the various racial groups that made up the South African population. During Apartheid, Limpopo was one of the black "homelands" or areas that black South Africans were confined to. Based on this legacy, Emily was referring to white South African ignorance and racist generalisations about where black South Africans come from, not factoring in that they may not even be South African.

taken care of," Emily explained, "they understand you don't have family, you don't know your way around." When she arrived at the division to do her PhD, she did not know that it was off the main campus, she did not know where to find accommodation, she "did not even know how to get from point A to B," nor where the division's building was. Emily told me that there was no support because "when you've been here for a long time you get comfortable." The international office on campus catered for "rich people from overseas" that came for two weeks to take electives at the university. In Emily's experience, it did not assist foreign African students besides providing a list of off-campus accommodation.

Alison was the vice-chair of the postgraduate council at the time that Emily started her PhD at the division and suggested that Emily join the council as a way to meet people. Since there were no structures to help students in her situation, Emily founded and set up an international student portfolio on the postgraduate council to help foreign African students and provide them with support and community. In her new position, Emily had to cultivate a relationship with the international student office on campus. She explained that this office did not do much besides register foreign African students. It did not run for "us the blacks. And we're here full-time," Emily said. This was not like the international student office on the main campus. Emily told me that on the main campus, foreign students were picked up from the airport and were assisted with on-campus housing. Comparing the African students on the main campus to the ones on her campus, she said, "They are liked the loved kids, we are like the orphan kids." When Emily made contact with the office, the woman in charge said that there were "so few" foreign African students. Emily was shocked, she had already recruited fifty in her term. "That's a lot, and that's not everybody," Emily said. Emily explained that she "wanted to get people together. So, the vision of this university is inclusiveness and I don't get the inclusiveness. I feel like this campus, I don't know what they're on about, but there's no inclusiveness that goes on anywhere, *for us*. I don't know about other people."

At the beginning of setting up the portfolio, Emily struggled. She felt that the students she was representing did not need her help because "they had been hustling for so long" and had become used to the "hostile" environment. There are interesting connections to the notion of *growing into it* that keep coming up. To care is to help the other grow, according to Milton Mayeroff (1971). Here there was a lack of care in what was described as a hostile

environment. Students needed to get used to it, or grow into it, without care from the faculty. Weaving further connections, in Chapter 2 my participants described the human body as a "hostile" environment experienced by *Mycobacterium tuberculosis.* For foreign African students, this university environment was extremely challenging.

Emily explained that she felt like she had to constantly beg for the time of the woman in charge of the international office because foreign African students were "not the priority." Emily spoke about the photos of the social events for the white international students in the woman's office. "We don't even know her like that. We are so afraid," Emily said. Emily organised a forum for "the abandoned kids" as a way to introduce the woman in the office to the students. "And all the students came to the forum which changed her perspective," Emily said. As I argued in Chapter 4, once one is in touch, it is hard not to care. It took contact – connection – for the woman's perspective to change. Emily described the impact of the forum:

> It was beautiful for the students to see the office is there for them because we just feel like you're here to just do your degree and then you're out. Nobody wants to stay on. Really. Nobody feels like it's a place where you really want to grow. Because who's interested?

Again, growth comes to the fore. Emily wanted to care, to help the other students grow in an environment that did not make them feel like they could grow because they were not cared for and made to feel they belonged. Emily wanted to change this narrative. Her care resembled Ingold's concept of "anthropogenesis," which he defines as "neither making nor growing, but a kind of making-in-growing" (2015: 122). Speaking about humans, Ingold explains, "They grow themselves and, since their growth is conditioned by the presence and actions of others, they grow one another. Indeed, 'growing one another' is as good a definition as any of social life" (2015: 120). This brings the discussion of interdependency and mutuality, particularly *mutual flourishing*, back into the warp and weft of the discussion, as well as the concepts of sympoiesis and the holarchy. In a very real way, Emily's experience showed that in order to grow, there needs to be care and the kind of connection that being

in touch and in tune brings. This weaves connections between the real need for human caring not just for other species, but for other humans.

This was exactly what Emily did. Her portfolio was a major success because she created an environment in which black African students felt they could grow. She built and maintained relationships with these foreign students and with the office. She organised social events that brought students together and increased their visibility so that the main campus was aware there was a community of foreign African students on the smaller campus. Before these events, Emily said that nobody knew they existed. She created a support group where the students could ask for general help, ask about accommodation, inquire about scholarships and funding opportunities, among other things. Based on Grace's experience recounted at the beginning of this section, a space where foreign African students could find out about funding opportunities was very important.

Through her caring, Emily had enacted real change. "It was painful for me going through all of that," Emily said about her experience. Helping students so that they did not experience the same pain was very important to her:

> When I finish, I would like to...before I start my bigger plan of NGO, whatever it is, I wouldn't mind to work in a university, get a position in a university in a student development something where I will be able to, maybe continue with the international student… I would like to be in this office, literally this campus office. Because I've been a student and I've managed to create that portfolio to exist and I'd like to be part of that, and just change some things from there.

I have described Emily's experience in detail because it not only shows how much she cared (where caring is the *action* of helping the other grow), but because it points towards some of what it means to be a decolonial scientist and decolonise scientific institutions. In Chapter 6, I focus specifically on this, describing how black students felt not just within the university space but within the institution of science. D.A. Masolo refers to this as "dépaysement," (2017: 29), a concept I pick up in Chapter 6 to reflect on the lack of belonging and disorientation black students feel in South African universities. What Emily did was no small

feat. Her actions serve as instruction manuals that could become tools of decolonisation in the context of the university and institutions of science. Making black students feel that they belong in white spaces is nothing short of decolonial. And Emily's care did not end there.

COMMUNITY MATTERS

Emily also set up what she called a "support group" for scientists that she named "Faith and Science." She explained that she started the group a week after a student suicide on campus. While we were getting changed into our P3 gear in the clean room one afternoon, Emily explained that the idea came out of her observation that scientists did not have anyone to talk to and very little support. She said that at their first meeting, a student from another university travelled a far distance just to attend. Speaking about this group, she explained:

> So, when you talk about going to therapy… not everybody has got the advantage or the luxury. So, for me, the sense of a small group is really important… And a lot of things really happen in small groups. So, I started a group. I just felt that there's so much need in my field… So, for me I decided to come up with a support for Christians in such an [scientific] environment… So, what we do, we basically just link the science and God. Like literally God created all of this that we're doing right now. And sometimes you don't really even have a topic. Like the last time we met, somebody just asked the question, a very personal question, and then we just talked about it. So, it was very therapeutic. So, she just asked the question: How can I know when to help somebody? … And people just spoke around that question, give advice and also still reflecting on ourselves, like 'okay I'm terrible at helping people when I'm also going through my own stuff.' And then others gave us their tips on how they do it.

Emily started the group to be of service, and the content of the group's meetings was about helping others and being of service. Emily said that the point of the group was to be brought together around what you love and "in that togetherness there is obviously some sense of growing relationships, growing support, growing." Again, Emily foregrounds growth, connecting care and growth to create an environment where scientists "thrive," as she explained:

> So, I had to ask them on the first meeting what their expectations were and those were the things that came up. Having a group that will be able to hear me and also value the thoughts… But because we're quiet and listening, that person really feels validated and like 'wow, people can actually listen to me.' And you never know how they'll *thrive* in their research because they have that support… I don't know how many foreigners, international students or whatever we want to be called, don't have a family. Like I don't have a family, like literally. So, we don't have anything to get back to… I need to go on WhatsApp to get to my family. So, it might help a whole lot of people that don't have anywhere else.

This group was about a deep sense of caring for the other and helping them grow. It was an "anthropogenic" (Ingold, 2015: 122) intervention – following Ingold's anthropogenesis – where taking time out from busy work schedules to *make* a space where people can *grow* contrasts the scientific environment where "People really are serious about publishing," as Emily said earlier. This picks up the discussion of scientific time and care time that began in Chapter 1 to show that what matters to scientists is not necessarily what matters in the fast-paced world of science. Slowing down their own research to help other scientists – to *make-in-growing* – was an important part of what my participants cared about. Emily had a theory on time spent helping other people:

> The thing is, every time I help, every time I take off my time, I feel for some reason it works. Like it's not like the person is wasting my time or anything. For me, rather I gained. Even if I'm not going to help you, but just listening. I don't know, like my time just gets added on, or my experiment's going to work, something just happens. So, a lot of people go like, 'no I'm too busy to help.' But you never know. What you give always comes back.

This links care time and scientific time in beautiful ways. Rather than opposing each other, Emily saw them as complimenting each other. By giving productive time to slower-paced care time, time could be "added on" or "gained." No time is wasted. This kind of thinking is powerful in envisioning ways to decolonise science, particularly because one of the major arguments that emerged in the student meeting that I discuss in Chapter 6 was that scientific faculties in universities were not welcoming and caring spaces for people of colour. Emily explained, "I felt there was a need in our division because everybody's very into productivity,

there is no personal thing." Emily tried to bring the personal into the scientific in very important ways. She was trying to create an environment where community and support mattered as much as scientific productivity. In fact, she suggested that productivity could be increased with the right community and support. This is very important.

HAVING A LIFE MATTERS

All of my participants cared about having "a life." For some that meant getting married, starting families, and having and caring for their children. For others, it was as simple as having time "to live" – to go rock-climbing, to pottery classes, to the gym, to Pilates classes, or having the time to read a book. Speaking about the kind of life she wanted to have and the kind of life she did not want to have, Alison said:

> I don't want that for my life, and I don't want the rat race, and I don't want an unbalanced life… So yes, you can have a balance and you can be successful in your career and in your family life. *But you have to determine what is success to you.* What does a successful life look like to you? And for me, it is a full life. I mean, you know that we want to have kids soon and all of that. So, it's being present with my family. It's reaching goals in my professional life. But more and more, I think that the things that were important to me as a younger scientist are not actually the things that matter. Because I don't see value in someone who works Monday to Sunday 5am to 10pm. There's no quality of life. You might be turning out fifteen publications a year with your collaborations, but… that's not quality of life.

Alison cared about creating a balanced life that did not follow the rhythms of a fast-paced scientific career. What she valued was not what science values. Leigh had a similar perspective. When I asked her about her schedule when she got home from work, she replied:

> I've been trying to be much better about it, I definitely want to exercise, switch off and stuff, but if there's like a paper or something that needs to be done, I've got to work on it at night because there's just not enough time during the day, you've got so many other responsibilities. You've got to work at night or on the weekend. And there's a lot of push for, like if you're not doing that as a scientist, you're not successful. But I think that's

> nonsense. You should be allowed to have time for yourself to switch off and relax. But the reality is that the very successful people do not have lives. That is the reality. So, I think I'm ok with that. You know like at the end of my life, hopefully I'm on my death bed and I'm not going to be like 'I'm so glad I published those thousand articles.' I don't think that's what I'm going to be worried about. So, I'm like ok with that. But that is the reality of science. You have to do that if you want to get ahead. Like [a colleague] has no life right now. He is just writing grant, grant, grant, grant, science, science, science, lab, lab, lab. That's all he's doing… That doesn't sound like a very enjoyable life to me. And no matter how much you love science… What life is that? But I don't know, I'm maybe an exception. Honestly my dream job right now would just be to open up a pottery studio and do pottery the rest of my life… Science has made me jaded. The system is not what I thought it would be. So that's made me very disillusioned… I don't know, yeah, I think I would miss it. At the end of the day, as much as I complain, I don't think I would want to do anything else… But we are constrained. Academia is constraining.

Leigh's affinity to pottery is very interesting. Pottery is a slow and time-consuming process that requires patience, much like work with *Mycobacterium tuberculosis*. Preparation, moulding, firing and glazing are intercepted with long periods of waiting. But importantly, in her answer, Leigh expressed the tension that is central to this thesis, the fast pace required by science that is at odds with the slower pace that my participants wanted to operate within, a pace that is becoming more and more important as I move into a discussion of decolonising science. Leigh's use of the word "constraining" points towards the inability for flexibility, for movement and for flourishing in a scientific environment, weaving threads of these themes that have been scattered throughout this thesis. The fast pace of science leaves little room for these elements, making it a difficult environment in which to survive, as Alison alluded to when she said:

> And I think a lot of women still are in that mindset of I must just give, give, give, give, give. Whereas when are you taking time for yourself? And it's perpetuated in academia because we just feel we need these deadlines. We can't exercise. We can't tell people we're not coping. We can't take time for a psychologist. We can't take leave… And then we burn out numerous times in the year. We have breakdowns numerous times in the

> year because we just think we have to do, do, do, do, do, do. And that actually cuts your productivity.

There needs to be time and space within institutions of science for the personal, for slowing down, for patience. Especially if the fast pace has detrimental physical and psychological impact on the scientist. It is attention to these kinds of struggles that will forge the way to creating better (decolonised) cultures and institutions of science. And recognising these struggles requires slowing down, allowing time to stop and think about how institutions currently are and how they could be. The #RhodesMustFall student protests, which I discuss in Chapter 6, quite literally forced institutions to come to a halt. The university timetable warped as students shut down university campuses across South Africa in their call for an interrogation of university culture. Students begged universities to interrogate what mattered to them, what they cared about and told them what they should care about. Important for students was the argument for science to be relevant to Africans and deeply complex African social formations and problems. This discussion is picked up in Chapter 6.

"TO NOT JUST STAY IN THE LAB": IMPACT AND RELEVANCE

Speaking about the very real impact that her laboratory work with rhinos had outside the lab, Emily explained:

> This is where I want my future, to be able to make this applicable. To not just stay in the lab… I want this science that I've learnt for the longest time, like how does it fit into the actual community? Like the impact. Like make it real, even if we don't talk about science.

"Impact" was a word that my participants continued to bring up. When it was used, they were not referring to impact factors in the sense of publishing in the right journals with high impact factors, but to describe research that had *relevance* to the community. This was exactly the difference between care as the reason for doing research that has an impact and fitting care to the research that is already being done. This tension was highlighted by the head of the division in the email he sent to me, which I discussed in the Chapter 2. It is the tension

between producing science that matters to the community rather than science that matters to scientists. My participants cared about the former. For example, Leigh said:

> I think the more I move ahead, I'm realising like I actually want to make a difference, like a real impact… You want to do something that is going to matter. And I think maybe studying one pathway for the rest of my life, as much fun as that would be, like I don't know if that would be the best use of my time and effort.

Leigh wanted to put her time towards research that mattered beyond the laboratory, research that would help people. This was what Alison was referring to when she said, "What I think care is, is not only doing what you're comfortable with, it's going beyond yourself and challenging yourself with things that are uncomfortable. That's care. Because if I just cared about this little thing in the lab, then that's not really care, that's just within my comfort." Alison's argument was around scientists not doing enough beyond the laboratory, which led her to ask whether they actually cared. These were the kinds of questions that arose in the meeting on decolonising science, which I explore in detail shortly in the following chapter.

Tronto asks an important question about the proximity of care, "How are we to guarantee that people, who are enmeshed in their daily rounds of care-giving and care-receiving, will be able to disengage themselves from their own local concerns and to address broader needs and concerns for care?" (1993: 142). The conflict that arose after my presentation, and the one to which I keep returning throughout this thesis, was around whether it was actually the responsibility of a basic scientist to disengage themselves from the concerns of their research to "address broader needs and concerns of care." How far should a laboratory scientist's care extend? This tension brings to the fore the modernist science/society, lab/real world binary because it asks scientists to move beyond the laboratory and engage with the world outside of it to create science that is relevant and impactful to the community in which they are based. This was a very big part of what decolonising science meant to the #RhodesMustFall students, as articulated in the meeting.

CHAPTER 6 – MUST SCIENCE FALL? AN ARGUMENT FOR GROWING A DECOLONIAL SCIENCE

A BRIEF INTRODUCTION TO THE #MUSTFALL MOVEMENT

To understand where the call to decolonise science came from, it is important to understand the climate on university campuses across South Africa in 2015. In March of 2015, University of Cape Town (UCT) student and activist Chumani Maxwele threw human faeces at the Cecil John Rhodes Statue at UCT's upper campus. His actions sparked the student movement that became known as #RhodesMustFall (#RMF), whose protests led to the removal of the statue[62]. In October of the same year, #FeesMustFall (#FMF) student protests – a continuation of the #RMF movement – began in response to the announcement of a 10,5% fee increase at the University of the Witwatersrand (Wits) in Johannesburg and a 10,3% fee increase at UCT for the 2016 academic year. South Africa's "rainbow nation" rhetoric was turned on its head when the anger from young black students who belong to the generation known as the "born-frees" was at a tipping point (Chikane, 2018)[63]. "Rainbow nation" and "born-free" were misleading, when the majority of young people of colour could not afford university education[64]. Those who managed to secure some form of financial aid to attend South Africa's tertiary institutions, felt the colonial roots both within the university as a space – with its colonial symbols such as the Cecil John Rhodes statue – as well as within its curriculum.

The #RMF mission statement articulated, "In our belief, the experiences seeking to be addressed by this movement are not unique to an elite institution such as UCT, but rather

[62] Rekgotsofetse Chikane (2018) as well as Susan Booysen and Kuda Bandama (2016) remind us that #RMF was the culmination of various discussions, mass meetings, initiatives and student frustration that occurred at both UCT and the University of the Witwatersrand (Wits) long before this incident. It is also important to note that #RMF and #FMF are extremely complex and nuanced movements. Please see Chikane (2018) for in-depth accounts of these movements that do not totalise or unify them.

[63] "Rainbow nation" was coined by Archbishop Desmond Tutu as a metaphor for the uniting of South Africa's racially diverse population after the end of apartheid. "Born-free" is a term used in South Africa to refer to those South Africans born after the end of apartheid; after 1994 (Chikane, 2018: 6). Lastly, "black" is used in line with #RhodesMustFall students' use of the term to "refer to all people of colour" (#RMF, 2015a: 6).

[64] The student protests against the fee increase led to the announcement by the president that there would be a 0% fee increase for the 2016 academic year. This was a huge victory, reflecting the power of the movement.

reflect broader dynamics of a racist and patriarchal society that has remained unchanged since the end of formal apartheid" (2015a: 6). The movement, therefore, extended beyond the South African university. Student activists such as Khumo Sebambo (2015) and Rekgotsofetse Chikane (2018) have articulated how the #RMF movement was about exposing racial inequality, social injustice and economic deprivation in the country. After all, Maxwele's political act of throwing faeces at the statue spoke directly to similar protest acts by residents of Khayelitsha – an informal settlement on the outskirts of Cape Town – over lack of service delivery and basic sanitation (Nyamnjoh, 2016: 77-78). The politics that were behind the movement cut deep into South Africa's history to bring to the fore its effects on contemporary South African life for people of colour. The student protests were indeed political protests that questioned the state of the country (see also Booysen, 2016; Chikane, 2018).

Although #RhodesMustFall began at UCT, its tentacles spread out to ignite student movements at universities across South Africa (Chikane, 2018: 81). Each of these movements mobilised around decolonising the university space and the curriculum – which included hiring and promoting black academics, ensuring black students were not financially and academically excluded from tertiary education, and the end to the outsourcing of workers on university campuses (#RMF, 2015b: 12; Chikane, 2018)[65]. Decolonisation also meant creating cultures of inclusivity on campus through addressing campus symbolism (Jansen, 2019a: 51) and rape culture (Sayed, de Kock & Motala, 2019: 158). "Decolonisation," therefore, became an umbrella term for the process of addressing a range of issues and injustices on South African university campuses.

#RMF preferred the term "decolonisation" to "transformation" as "Transformation is the maintenance and perpetuation of oppression, hidden within meaningless surface-level change" (#RMF, 2015b: 12). Drawing on Valerie Hey's phrase (2003), André Keet has referred to this as "intellectual hair spray" (2019: 206). This phrase captures the superficial change that has occurred after apartheid at South African universities. For the students, this change has had no impact on what Jonathan Jansen has called the "institutional curriculum" (2009:

[65] Amina Mama (2015), Suren Pillay (2015), Mahmood Mamdani (2019) as well as Yusuf Sayed, Tarryn de Kock and Shireen Motala (2019) each remind us that decolonial movements have been active in African universities for many years, South Africa is not exceptional.

178). The institutional curriculum refers to "the knowledge encoded in the dominant beliefs, values and behaviours deeply embedded in all aspects of institutional life" (Jansen in Lange, 2019: 86-7). According to Jansen (2019a) and Lis Lange (2019), the institutional curriculum is pervasive and resilient. Keet (2019) has equated the deep-rooted stability of the institutional curriculum with Pierre Bourdieu's concept of "habitus" (1977) to show how certain ways of being and producing knowledge are already pre-defined. For this reason, the consensus among the students was that the university's transformation practices have failed at tackling this persistent and unchanging culture. Chikane writes that "#RhodesMustFall was the reaction to a combination of instances where moments of headway made towards transforming UCT were negated by the institutional culture of the university wanting to bring it back to equilibrium" (2018: 48). To understand this, it is important to understand just how powerful the "stench of colonialism" (Sebambo, 2015: 108) was in the formation of the African university.

THE COLONIAL UNIVERSITY #MUSTFALL

The African university was not modelled on the great precolonial African institutions such as those in Timbuktu, Cairo, Tunis and Alexandria (Mamdani, 2019: 17)[66]. It harnessed its structure and intellectual content from European institutions (ibid). The African university was first and foremost a "colonial project" preoccupied with the colonial "civilizing mission" (Mamdani, 2019: 17). The logic of the African university was, therefore, based on the "superiority of colonial knowledge" and the "inferiority and incompleteness" of the colonised (Lange, 2019: 88). This inferiority was "scientifically" proven (Langerman, 2012: 185n3; Roy, 2018; Lange, 2019). This highlights that the African university "has very little to do with what existed on this continent before colonialism, and everything to do with what was created in modern Europe" (Mamdani, 2019: 17). This brings the argument of relevance to the heart of the discussion, an argument that frames this chapter.

[66] To reiterate footnote 15 earlier in this thesis, to write about this broad topic, "Africa" and "African" are used to refer to the African continent and its people. They are used with full recognition that Africa is not a single homogenous continent, but a continent made up of diverse nations, people, cultures and knowledges. For the purpose of this chapter, the generalisation takes its use from the students and academics cited in this chapter (see also footnote 15).

Significantly, this model of the university, with its organisation, knowledge, institutional culture and staff as well as student demographics, has not been radically rethought in post-colonial and post-apartheid South Africa (Le Grange, 2019: 34). #RMF students propelled academics and South African society to interrogate the politics of knowledge within the African university. At the core of this politics of knowledge is that the African university is merely an extension of its Euro-American origin, with the aim of being recognised as such, rather than a distinct and profoundly unique *African* institution (Mbembe, 2015). African universities strive to meet international standards, competing internationally and conforming and subjecting themselves to international rating systems (Nyamnjoh, 2017: 137). But, as I show in the following section, prioritising what is valued internationally could come at the expense of what is and could be *meaningful and relevant* locally. Important for the context of this research, as Shadreck Chirikure notes, is that "the laboratory and science" are "two of the most iconic attributes of the modern (Western) knowledge-production system" (2017: 63). This places science at the centre of the calls for interrogating the politics of knowledge and decolonising the university.

#SCIENCEMUSTFALL

In early 2016, #RhodesMustFall began protesting the lack of student accommodation. As a demonstration, students erected a shack at the University of Cape Town's upper campus, and the protests became known as the #ShackvilleProtests. The presence of the university's colonial roots was still at the forefront of the movement, and protestors burned some of the University's art that they felt symbolised the coloniser (Chikane, 2018: 219). The need for decolonisation was imperative, and the students continued to propel the university to interrogate its colonial heritage and decolonise its curriculum.

Science was not immune to these demands, and its particular relationship to colonisation and the subjugation of people of colour and alternative ways of knowing was put under the microscope with a YouTube video titled, "Science Must Fall?" (UCT Scientist, 2016). The video went viral, getting over a million views. After the upload of the video clip, the phrase "decolonising science" spread like wildfire, finding traction in news articles, opinion pieces and academic articles that often responded directly to the video (A. Eloff, 2016; D. Eloff, 2016;

Illing & Sloan, 2016; Crowe, 2017; Ally & August, 2018; Nordling, 2018; Roy, 2018; Hoadley & Galant, 2019; Blackie & Adendorff, 2020; Green, 2020; Sarukkai, 2020). The video was, in fact, part of a longer two-hour meeting organised by a group of predominantly science students at UCT in October 2016 (see Schulz, 2016). The meeting occurred around the time of the #FeesMustFall protests of 2016, which were a response to proposed student fee increases for the 2017 academic year. University fees and the pervasiveness of the colonial university and its institutional culture were two major and entangled challenges that South African students were taking on. The group that organised the meeting mobilised under the name "Science Faculty Engagements," and their aim was to engage the decolonisation question in science during a series of panels. The viral video (see UCT Scientist, 2016) shows panelist, undergraduate politics and philosophy student Mickey Moyo, saying[67]:

> If I personally were committed to enforcing decolonisation, science as a whole is a product of Western modernity, and the whole thing should be, like, scratched off. We have to restart science from, I don't know, an African perspective, from our perspective, of how we have experienced science. For instance, I have a question for all the science people: There's a place in KZN called Umhlab'uyalingana, and they believe that through the magic, the Black magic… witchcraft, they believe that you are able to send lightning to strike someone. So, can you explain that scientifically because it is something that happens.

At this moment, an audience member interrupts Moyo, saying, "It's not true!" After much chaos from the interruption, the meeting is brought back to order and the student who interrupted her apologises. Moyo continues:

> See that very response is the reason why I am not in the science faculty…. I did science throughout my high school years and there was a lot of things that I just… Western modernity is the direct antagonistic factor to decolonisation, because Western knowledge is totalising. It is saying that it was Newton and only Newton who knew or saw an apple falling and then out of nowhere decided that gravity existed and created an equation and that is it. Whether people knew Newton or not, or whether whatever

[67] See also Lesley Green (2020: 82-88) for an analysis and discussion of Moyo's speech as well as Green (2020: 101-105) for a direct response to Moyo's argument.

> happens in Western Africa, Northern Africa, the thing is that the only way to explain gravity is through Newton, who sat under a tree and saw an apple fall. So Western modernity is the problem that decolonisation directly deals with. To say that we are going to decolonise by having knowledge that is produced by us, that speaks to us, and that is able to accommodate knowledge from our perspective. So, if you are saying that you disagree with our approach it means that you are vested in the Western and Eurocentric way of understanding, which means you yourself need to go back, internally, and decolonise your mind, come back and say, "How can I relook at what I've been studying all these years?" Because Western knowledge is very pathetic, to say the least… Decolonising the sciences would mean doing away with it entirely and starting all over again to deal with how we respond to the environment and how we understand it.

Moyo raised important concerns. These included the superiority of Western knowledge in the university, the unfettered authority of science – or scientism, – the inaccurate assumption that science is the product of the global North, the need for epistemic diversity within the curriculum and academy, the pressing need for scholarship that is relevant to Africans and the persistence of modernity's binaries including truth/belief, science/spirituality and nature/culture. These important concerns that were brought to the attention of the students in the meeting were eclipsed by Moyo's argument that science should be "scratched off." A fraction of the number of people who watched this video clip watched the longer meeting in which UCT science students spoke about their views on science and decolonisation as well as provided highly important and productive arguments (see Schulz, 2016). None of these students agreed that science should be scrapped. "I'm not saying debunk it," one student said. "And we don't need to throw away the scientific method, guys. It works," said another. But there was consensus in the room that the focus of science in South Africa, the way in which it is taught and what is included and excluded in the curriculum needed to be radically interrogated.

I have outlined these events in detail because this was the climate in which I began conducting fieldwork at a university-based scientific research laboratory in 2016. As I have stated elsewhere, research does not happen in a vacuum. The awareness of the need for porous boundaries between science and society meant that this ethnographic research was not

insulated from the very important discussions that were happening on university campuses across South Africa. I am not a curriculum theorist, nor an expert on decolonial theory. I am not a "hard" scientist either. Importantly, the topic of decolonising science requires extensive research from Africans since "the task of decolonisation cannot be left to the coloniser" (#RMF, 2015c: 15). Thus, there is the question of how, as a middle-class white South African, can I write about decolonisation? The bigger question, I believe, is how can I not?

As an anthropologist conducting research in the field of STS in South Africa at a time when the reverberations from the protests linger on, eliminating this topic from social research on science in South Africa at this moment isolates my research from the socio-political context in which it is embedded. Eliminating it would also contribute to the erasure of significant and marginalised voices in the production of knowledge in South Africa. Furthermore, it would contribute to the kind of "distance" and "disinterest" that white university students have shown towards these politics (Chikane, 2018: 77-8). Collapsing distance, particularly the distance between the lab and the outside world, has been a central argument in this thesis. Dissolving the imagined boundary between science and society to become *interested*, or as Isabelle Stengers would say, to "become infected by such things" (2018: 37) – the things that concern society – is a vital part of good research. My discussion of decolonisation follows this line of thought.

In this chapter, I weave some of the main arguments brought forward by UCT students during the two-hour Science Faculty Engagement meeting with the writing of #RhodesMustFall student activists, the work of African academics (often in response to the student protests in South Africa and the call to decolonise the curriculum) and African STS scholars[68]. Using what the students articulated as the foundation of this chapter and its themes brings their voices to the fore and allows them to shape its unfolding. I hope in this way, I remain available to their visions of becoming. I rely heavily on the scholarship of African academics to navigate this topic, stepping away from the common default of thinking with theory from the global

[68] The two-hour Science Faculty Engagement meeting to which I refer throughout this chapter can be found on YouTube (see Schulz, 2016). The direct quotes from students have been taken from this video recording of the meeting. The writing of #RMF student activists can be found in The Johannesburg Salon (2015), which is available online (see The Johannesburg Salon in the reference list).

North – a perpetuation of the colonisation of knowledge and academia that I touched on briefly in the Introduction with references to *salaula*. As I noted in the Introduction, one of the students in the Science Faculty Engagement meeting said, "I don't think anyone is coming here with answers. We all don't have answers… But it's a commitment to finding out" (see Schulz, 2016). The students in that meeting called for a commitment to finding out what a decolonised science and science education might look like. In Chapter 2, I highlighted that the difference between concern and care is that while to be concerned is to be worried or affected by something, to care is to be attached to something and *committed* to action (Puig de la Bellacasa, 2017: 42). What follows is a small part of that commitment.

Since decolonising science is directly linked to the decolonisation of knowledge, this chapter takes into account decolonial scholarship. But since decolonisation is a broad topic that requires much more space than a single chapter, the focus has to be narrowed[69]. The focus of this chapter is how South African students in the #RMF movement have engaged with the decolonisation question in science. In particular, the focus is on their argument of the need for *relevant* science. In other words, science that connects with and responds to the African context. The ethnographic research that I conducted with my participants and the theory that was developed from this research speaks to the student discussions in significant ways. Juxtaposing the conversation from students about decolonising science against my research shows the ways in which it constellates around the arguments that I (as well as my participants) have made in this thesis for a caring science. A caring science being one that is reunited with society so that society drives what scientists care about. As I argued in Chapter

[69] For decolonial theory borne out of the anti-colonial movement, see W.E.B. Du Bois (1903), Aimé Césaire (1950), Frantz Fanon (1961, 1970), Leopold Senghor (1964) and Albert Memmi (1965). For later work on decolonisation in the "post" colony, see Latin American scholars such as Ramón Grosfoguel (2007), Nelson Maldonado-Torres (2007, 2011, 2016), Walter Mignolo (2007, 2009, 2011), Aníbal Quijano (2007), Boaventura de Sousa Santos (2007, 2010, 2013) as well as Mabel Moraña, Enrique Dussel and Carlos Jáuregui (2008). Many African academics have taken on the issue of decolonising the university and its curriculum, many responding directly to the student protests (Garuba, 2015; Mbembe, 2015, 2016, 2019; Boughey & Mckenna, 2016; Le Grange, 2016; Luckett, 2016; Luckett & Naicker, 2016; Mamdani, 2016; Nyamnjoh, 2016; Jansen, 2017; Leibowitz, 2017; Morreira, 2017). Especially significant is the book *Decolonisation in Universities: The Politics of Knowledge* (2019b) edited by Jonathan Jansen. Some wrote about these issues long before the student protests (wa Thiong'o, 1986; Hountondji, 1990, 2009; Mamdani, 1993; Smith, 1999; Wiredu, 2000; Mbembe, 2001; Odora Hoppers & Richards, 2012; Nyamnjoh, 2012). There have also been some important lectures given across South African universities including but not limited to those by scholars such as Amina Mama at UCT (2015), Mahmood Mamdani at UCT (2017), the "decolonising science panel" that took place at UCT with controversial scholar Chandra Kant Raju (UCT, 2017a, 2017b) and Nelson Maldonado-Torres at the University of Pretoria (2019).

2, a caring science is not just a translational science, but a *relational* science. It builds and assembles relationships as well as maintains them. Relationships across modernist binaries, relationships with communities and relationships with society. This is what the students in the Science Faculty Engagement meeting were calling for in their discussion on decolonising science.

Owing to the narrow focus of this chapter, there are important discussions that have to be omitted. Some of these include the violent history of science in Africa – how the birth of modern science coincided with colonial expansion and the racist ideologies that underpinned it (see also Fanon, 1970; Nandy, 1988; Raj, 2006; Anderson & Adams, 2007)[70]. Scientific and technological innovations such as guns, ships, steamboats, quinine, cartography and the radio to name a few, occurred alongside and enabled colonial expansion (Fanon, 1970, 1967; Headrick, 1981,1988, 2010; Nandy, 1988; Adas, 1989, 2009; Raj, 2006; Anderson & Adams, 2007; Storey, 2008; Delbourgo, 2010; Mavhunga, 2017b; Roy, 2018; Green, 2020). Medical technology has been used to exploit and experiment on people of colour (Petryna, 2009; Tilley, 2011; Peterson, 2014; Prasad, 2014). Scientists such as Sir Francis Galton and Charles Darwin openly asserted that humans with black and brown skin were intellectually inferior (Roy, 2018). Scientific "evidence" chronicled a relationship between skull size and intelligence, justifying racial hierarchies (Langerman, 2012: 185n3). This history connects science to colonisation and the extreme (physical and structural) violence towards people of colour. Science played a central role in creating authoritarian knowledge that justified the colonial project and its underlying ideologies. This racial scientific thinking carried on and informed apartheid in South Africa, making science a particularly untrustworthy discipline in post-1994 South Africa. But although science has this brutal history in Africa, science itself is not solely a product of the global North.

The students in the meeting spoke to the rich history of science in Africa that attests to the fact that science existed on the African continent long before colonisation (see also Rodney,

[70] Anthropology also shares this violent history and is therefore not immune to the decolonising project. The birth of anthropology coincided with colonisation. The knowledge of local populations that anthropologists obtained through ethnography assisted in the control and domination of the very same people (see Nyamnjoh, 2015: 58).

1972; Cooper, 1994; Bisson, 2000; Mitchell, 2002; Chirikure, 2005, 2006, 2015, 2017; Chirikure, Hall & Rehren, 2015; Killick, 2015; Louis, Nazemi & Remer, 2017; Masolo, 2017; Mavhunga, 2017b, 2017c; Raju, 2017). The students spoke to how African knowledge was stolen and exploited (see also Shiva, 1997; Osseo-Asare, 2014), and therefore called for the acknowledgement of "African" science and a re-centring of Africa in the field of science. They pointed to the need for deep reflection around what counts as legitimate knowledge and the methodologies through which that knowledge is obtained. Generational knowledge that was based on scientific principles such as observation, experimentation and trial and error are as valuable as knowledge obtained in a scientific laboratory. Each of these arguments showed that the Eurocentrism of science and its history often hides scientific innovation in Africa (see also UCT Left Students Forum, 2016; Mavhunga, 2017d). This moves beyond the pervasive and racist discourse of Africa as primitive, pre-industrial and pre-scientific so central in the well-known accounts of Georg Wilhelm Friedrich Hegel (1837) and Joseph Conrad (1902).

Furthermore, and in line with Moyo's argument, the students spoke to the particularly privileged epistemological position of Western science in relation to other ways of knowing (see also Césaire, 1950; Nyamnjoh, 2012; Mavhunga, 2017c; Le Grange, 2019). Decentring a Eurocentric curriculum in favour of recentring other ways of knowing has been a central framework for African scholarship on decolonising knowledge in the university (see Hountondji, 1990; wa Thiong'o in Mbembe, 2015; Mungwini, 2016; Jansen, 2019a; Sayed, de Kock & Motala, 2019). Lesley Le Grange calls this approach "cognitive justice" (2019: 33). Thus, instead of a *uni*versity, decolonisation calls for a "pluriversity" (Mbembe, 2015, 2019). These were some of the very important arguments brought forward by the students in the meeting. For the focus of this chapter, however, an argument for *relevance* is what needs to be woven. For the students in the meeting, the superiority of scientific knowledge came at a personal cost. They felt, as the next section discusses, that their beliefs had no place in the university space.

"THERE IS NO ANCESTORS, AND THAT'S MY WHOLE BELIEF"

A student in the meeting, continuing the conversation around truth and belief that Moyo had started, said to the audience that in science, "there is no ancestors, and that's my whole

belief… You must have a space to accommodate people's beliefs." She went on to ask, "So how do we get to a place where scientists… don't reproduce the same things? … So that in future generations, another culture or another race doesn't come into this space and feel like their whole existence… because it can't be explained by a formula… doesn't exist." Both this student and Moyo, like other students in the meeting, were grappling with the separation between truth/belief and science/culture. Students felt like they had to shut off a huge part of themselves both within the university space and within their learning of scientific knowledge. Much of this had to do with what the authority of science has come at the expense of. Science gets the status of "knowledge" and "truth," while other ways of knowing are placed into the category of "belief" and "culture" (see Comaroff & Comaroff, 2012b). After all, as Clapperton Chakanetsa Mavhunga notes, "Thales, Aristotle, Plato, and other Greco-Roman natural philosophers are the "founding fathers" of science because they separated the natural from the spiritual" (2017b: 3). The binaries between nature/culture and natural/spiritual – and by extension science/culture and science/spirituality – were at the root of much of the tension as students tried to navigate paths to decolonise science. The students were deeply affected by these separations.

Noluvuyo Mjoli, an honours student and #RMF member, writes in a moving article, "I envision a decolonised UCT as a brave new world has places for people like me that come from the village and townships of South Africa… Where my culture won't have to remain at the gate of UCT, waiting for me to fetch it when it is vacation" (2015: 112). African academics have also written about this physical and psychological separation between knowledge and culture, home and school. Mavhunga writes, "Bench science… remains an elitist, university-centered practice, something taught in class in primary and secondary school and usually left there. It doesn't come home—to the village, to the streets" (2017b: 9-10). While Mavhunga (2017b) speaks to the notion of relevance, a theme dealt with shortly, he begins to grapple with the separation and disconnection that the students spoke to. D.A. Masolo also addresses this, writing:

> The temporal and incremental trajectory of the separation between the local and the "new and important" knowledge became a visible process of mental and finally also social "dépaysement." Home and school gradually became two vastly different worlds: one

> ruled by important knowledge about a world that was distant physically, socially, and theoretically and the other by an array of knowledge regarded to be simple and domestic. The disconnect between these two realms has defined how many of us have grown to classify knowledge, claiming sometimes that indeed they are and ought to be kept apart (2017: 29).

The word “dépaysement” is a powerful word because it articulates the kind of disorientation that comes from being in a foreign place with unfamiliar beliefs, customs and worldviews. This is how many black students felt within the university (see The Johannesburg Salon, 2015 especially Mjoli, 2015). A student in the Science Faculty Engagement meeting spoke about being “made to feel like you do not belong” in the biology department. Another student asked, “How can we make black bodies feel comfortable and acknowledged within the science faculty to foster black academics, especially in the science, technology, engineering and mathematics (STEM) fields?” In Chapter 5, I detailed Emily’s experience as not only a black person, but a foreign African person within the university space. Her experience speaks volumes to these feelings of dépaysement and the need for the creation of inclusive and caring institutions of science.

For other students in the Science Faculty Engagement meeting, some of this dépaysement came from the exclusion of the spiritual and cultural in both the university curriculum and the science curriculum. Francis Nyamnjoh (2012) writes about the importance of recognising “popular epistemologies” in Africa for this very reason. Nyamnjoh explains, “Far from subscribing to rigid dichotomies, popular epistemologies *build bridges* between the so-called natural and supernatural, physical and metaphysical, rational and irrational, objective and subjective, scientific and superstitious, nature and culture, visible and invisible, real and unreal, explainable and inexplicable” (2012: 131, emphasis added). Dissolving the boundaries between these binaries creates epistemologies that are relevant to the students. As I have continued to show in the chapters leading up to this chapter, the ability to build bridges, to make relations across borders, boundaries and binaries is key to decolonisation. The students called for a science that does not lead to their dépaysement, their alienation or ask them to leave their culture at the door. This is not an impossible goal. In his “#Azaniahousediaries,” student and activist Shabashni Moodley wrote about how the University of KwaZulu Natal

(UKZN) has “a Traditional Medicine Wing/curriculum at the Med school and an Indigenous Knowledge Centre of Excellence” (2015: 119). These inclusions are about inserting what Africans care about into what science cares about. Again, the importance of a science that responds to the community in which it exists is paramount.

“WHAT ABOUT AFRICAN PROBLEMS?”: THE CALL FOR RELEVANT SCIENCE IN SOUTH AFRICA

When the conversation was opened up to the audience right after Moyo spoke, one of the students stepped forward and said that the issue with science is that it addresses “European and Western problems” (see Schulz, 2016). “What about African problems?” he asked. He continued, “How are we developing solutions in science to solve African problems? That is decolonising science.” Like Moyo, many of the students voiced the need to address the disconnect between the “truth” that science seeks and the life-worlds and experiences of Africans who feel isolated by science. Many of the students felt that the university “does not speak to the lived experiences of the majority of the people that exist in South Africa… does not speak to anything that resonates with black people,” as one of the panelists said at the onset of the meeting (see Schulz, 2016). This alienation was sometimes felt in tangible ways. A science student said, “Astronomy textbooks are made for the northern hemisphere. So, you literally have to turn it upside down… When you get here [to university], the book doesn’t reflect your reality” (see Schulz, 2016). This is a physical example of the disconnection between the discipline of science and African realities.

In their formal written statement, #RMF asserted that one of their long-term goals was to “Re-evaluate the standards by which research areas are decided - from areas that are lucrative and centre whiteness, to areas that are *relevant* to the lives of black people locally and on the continent” (2015a: 8, emphasis added). This echoes the UCT Left Students Forum – a student group central to the #RMF movement – who stated in their Facebook response to the viral video, “To decolonize science we mean among other things, the use of scientific knowledge to advance a humane society where *the needs of people* drive innovation and knowledge production” (2016, emphasis added). The UCT Left Students Forum go on to say:

> Teaching science must mean teaching… the social context of the advancement of scientific knowledge. That way science students are not isolated in laboratories to be fed ideas from the public relations unit of pharmaceuticals, engineering firms and bio-technology companies. *A science student lives in the real world, her training must make her a socially conscious being* (2016, emphasis added).

The students were calling for a decolonised science that moves away from the concerns of industry towards a science that is "with the people" (Chirikure, 2017: 76). This means that scientific knowledge needs to respond to African problems, or in other words, problems that are *relevant* to Africa. Weaving back to the discussion on care in Chapter 2, it is important to remember that Nel Noddings (1984), Joan Tronto (1993) and Virginia Held (2006) framed caring as being attentive and responsive to need. Noddings wrote that the ethics of care is "rooted in receptivity, relatedness, and responsiveness" (1984: 2). The one caring needs to be receptive and attentive to what the cared-for needs. This requires "relatedness" or connection so that appropriate action can be taken to respond and meet those needs. A caring science is a decolonised science. A caring science is one that *connects* the laboratory and the world outside of it so that it responds in relevant and meaningful ways. I have been arguing for this kind of science, following my participants reflections and actions, throughout this thesis. The absence of a science that connects was one of the main issues that the students (and many of my participants) had with the current state of scientific research in South Africa. Hence why the UCT Left Students' Forum (2016) stressed that it is paramount that "A science student lives in the real world."

Students, therefore, voiced a disconnect between institutions of learning and knowledge production and the (African) world[71]. It is because of this disconnection that Nyamnjoh spoke

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[71] Mamdani (2019) argues that these issues are not new on the African continent. Academics have been speaking about the need for universities to be relevant to African societies for many years. Notable is the debate between *excellence* and *relevance* that occurred in East Africa in the early 1960s between Ali Mazrui at Makerere University and Walter Rodney at the University of Dar es Salaam (Mamdani, 2019). Makerere was the archetypal "colonial university," home to the "universal scholar," dedicated to excellence and preoccupied with ideas (Mamdani, 2019: 18). The University of Dar es Salaam, on the other hand, was an anti-colonial nationalist university, home of the "public intellectual" who is "located in his or her time and place, and deeply engaged with the wider society" (ibid). Interestingly, the interrogation of the place of the University of Dar es Salaam in the country was sparked by student protests, which propelled academics in the university to ensure the university became *relevant* to Tanzanian society (Mamdani, 2019: 20).

about African intellectuals as "potted plants in greenhouses" (2012). Writing about the separation between the knowledge produced in universities and the needs of African communities, Nyamnjoh argues that educated Africans "need to be able to come out of their greenhouses, where they are cut off from their surroundings, and encounter everyday Africa" (2012: 136)[72]. Nyamnjoh speaks directly to the severing of institutions of higher education with the communities in which they exist. Because of this disconnection, education in the "post"-colony, according to Nyamnjoh, is just "excellence in irrelevance" (2012: 136). Academics are more concerned with "external recognition and environments" than with "internal relevance" (Nyamnjoh, 2012: 134). This is precisely what the students in the Science Faculty Engagement meeting were arguing. Science addresses "European and Western problems," said the student. "What about African problems?"

To avoid this irrelevance, Nyamnjoh urges for "educational institutions and curricula and pedagogies *in touch and in tune* with their predicaments" (2012: 147, emphasis added). He stresses *relevance* and *connection*, particularly "reconnecting universities to lived life and embedding research in African communities" (Nyamnjoh, 2012: 148). This ensures academics come out of their metaphorical greenhouses. In Chapter 4, Leigh spoke about how being in touch with the world beyond the laboratory makes for a better and more careful and caring scientist. In that chapter, I argued that for my participants, the lab was *in touch* with the world. Their care, their touch and being touched, brought the space of the lab and the "real world" together. This continued beyond the laboratory, as I argued in Chapter 5. It is in these connections between institutions of learning and the world beyond them that Achille Mbembe (2015) imagines decolonisation.

For Mbembe, decolonisation involves reinventing the classroom by breaking the walls that exist between the sites of education and the public (2015). In his presentation, "Decolonizing Knowledge and the Question of the Archive" given at the University of the Witwatersrand in 2015, he speaks about a decolonised institution as "*a classroom without walls* in which we are all *co-learners*; a university that is capable of convening *various publics in new forms of*

[72] This disconnection contributes to the alienation that educated Africans feel from their community as they climb the institutional ranks. Student activists such as Gamedze and Gamedze (2015: 1) and African academics such as Nyamnjoh (2012, 2016) have articulated this in their writing.

assemblies that become points of convergence of and platforms for the redistribution of different kinds of knowledges" (Mbembe, 2015, original emphasis). Both Mbembe's (2015) and Nyamnjoh's (2012) argument for a decolonial institution find much resonance with Mahmood Mamdani's (2019) "public intellectual" and Isabelle Stengers' (2018) calls for a "public intelligence" of science and "civilised scientists" (2018). What emerges in each of these concepts are individuals and institutions that are aware of what society cares about, of the porous boundaries between the lab and the world outside and of the need for connection between institutions of knowledge and the communities and contexts in which they exist.

This is what a physics student was arguing in the meeting when she said:

> Science doesn't happen in a vacuum. Even though we're doing our research, it has an impact on something and we need to keep that in mind… We do need to look at our science, look at our methods, and look at where our knowledge comes from… And we don't need to throw away the scientific method, guys. It works. But we do need to look at our curriculum, where our knowledge is coming from and how we go about doing science and what the impacts are. We really need to consider those things. And I know it is difficult. But we're scientists. We're trained to train ourselves in these things. We can listen to people from the other side of campus, actually listen and try to understand. Not just 'Ah they don't know what they're talking about, I'm just going to concentrate on my really really smart science stuff' (see Schulz, 2016).

The science student was arguing for scientists to consider the world upon which their science impacts, to think beyond the laboratory and the classroom and engage with various publics. This connects again to the UCT Left Students Forum when they wrote that "A science student lives in the real world, her training must make her a socially conscious being" (2016). Each of these students and academics were interrogating the role the university should play in society. Each spoke to the need for a shift from the university and the laboratory as bounded to it as permeable. This involves a shift from unidirectional flows of knowledge from the university and laboratory to the world to transmissions that allow for the community and world to inform the university and laboratory. As this thesis has stressed throughout, flows and connections are important. Education in Africa, which followed the colonial model,

"champions static dichotomies and boundedness of cultural worlds and knowledge systems" (Nyamnjoh, 2012: 129). Both the students and African academics I have cited thus far have stressed the need for the relevance of the African university, connecting the African university to Africa and moving beyond the stasis and boundedness of the colonial modern model. But there are indeed issues with a preoccupation on being solely relevant to African society.

During the meeting, a white student said:

> You run the risk of it not being relatable to international forums where a lot of good work is done… So that's my only concern and I wondered if anyone else had an opinion on how we could tackle that issue because you want to maintain that ability to cross borders because science can cross borders, so we need to try and maintain that and assure us so that we don't lose that option of accessing other minds, other funding opportunities for conservation. But still maintaining the focus on making sure we focus on the southern hemisphere (see Schulz, 2016).

What she suggested was striking the balance between relevance and excellence. For Mamdani, a decolonised university balances relevance and excellence, local and global, society and scholarly community (2019). Mamdani writes, "To pursue this quest is to bridge and close the gap between the public intellectual and the scholar" (2019: 26). But many of the students felt that relevance must be the main priority. Nyamnjoh agrees when he argues that "academics and researchers from and on Africa cannot afford to be blind to the plight of African scholarship whatever the pressures they face and regardless of their own levels of misery and need for sustenance" (2012: 147). But relevance can lead to excellence, as Jansen (2019a) has shown with reference to particular scientific research projects, and as my participants' scientific research shows. Innovation, central to science and scientific research, comes out of creative solutions to *local* problems (Masolo, 2017: 36). Relevance needs to be at the foundation of scientific exploration and innovation[73]. That is a decolonised science.

Importantly, Mavhunga (2017c) and Chirikure (2017) both write about the African laboratory as a *relevant* laboratory. Mavhunga writes about *chimurenga*, which is "the arts of war

[73] This is the "salience" that I referred to in Chapter 5.

derived from *Murenga*, or Mwari, god of *vedzimbahwe* (or 'Shona' people) of Zimbabwe" (2017b: 23). *Chimurenga* is a laboratory since within *chimurenga*, there is observation, experimentation, trial and error, verification and disproof and peer review (Mavhunga, 2017c). Chirikure, an archaeologist, researches precolonial metallurgy and pottery making. Both academics use these examples to show Africa's rich science, technology and innovation history. Importantly, precolonial African science and innovation took place in homesteads, communal areas and outside, breaking down the barriers between the lab and the world that are so characteristic of Western science. This was because the precolonial laboratory "was always *with the people*, be it in the agricultural fields of Mexico, the stone construction at Great Zimbabwe, or the irrigation in Papua New Guinea" (Chirikure, 2017: 76, emphasis added). Communality was more important that proprietorship (Chirikure, 2017: 73). As Chirikure explains, "knowledge was communally owned" rather than patented, ensuring "inventors, innovators, and improvisers worked not just for themselves but also for the community at large" (2017: 76). The interests and needs of community were at the centre of scientific and technological innovation. According to Chirikure, this is what distinguishes the precolonial African laboratory from the modern day Western one (2017: 73-4). Community and relevance are fundamental to African ways of knowing (Chirikure, 2017: 77). These orientations are thus key to decolonising science.

While Mavhunga (2017c) and Chirikure (2017) provide examples of the precolonial African laboratory, Jansen (2019a) provides examples of what he considers to be a decolonial African laboratory. The two examples of contemporary scientific research projects that Jansen references disrupt the unidirectional flow of science and knowledge from North to South, or what he refers to as "the centre periphery thesis" (2019a)[74]. Importantly, they are both *African-focused* and *relevant* to African problems (Jansen, 2019a: 71). It is clear that a strong theme that is emerging from the precolonial and decolonial African laboratory is relevance. Relevant science that responds directly to the African context becomes central to the decolonisation of science. To be relevant, science has to understand its connection to the community in which it exists. It needs to form a relationship with the world beyond the

[74] These examples speak to the argument made by Jean and John Comaroff (2012b) on the reverse flow of knowledge from South to North that I referred to briefly in the Introduction.

laboratory. As I explained in Chapter 4, making relations involves breaking all sorts of boundaries and requires deep understandings of flows and movement. Flow and movement are important concepts for decolonial thinking too, especially for science.

FLOW AND MOVEMENT

Lesley Green asks, “When and why did modernist knowledge that arose in the Enlightenment era begin to focus on forms in empty space?” (2020: 227). In other words, without attention to relations, flows and movement. Conceptualising flow and movement are one of Green’s (2020) proposals for transformative transdisciplinary scholarship. She argues that attention to flow and movement provide pathways for decolonised scholarship. According to Green, flow and movement get us out of the static and bounded categories of modernist thought, namely, subject/object, nature/culture and science/society (2020: 225). Green explains, “scholarship that attends to flow and movement offers the beginnings of a route to a knowledge of nature that is free of the fiction that nature is composed of singular objects that may be described in science against a blank background of space and time” (ibid). Therefore, and as I argued in Chapter 4, flow and movement create relations and collapse boundaries. Flow and movement are also central to traditional ways of understanding the world, such as Aboriginal songlines, Amerindian taxonomies, Navajo language and Khoe cosmology (Green, 2020: 252). Green therefore argues for “the critical importance of decolonising thought, resisting the categories and stasis that are the dominant intellectual heritage of universities” (2020: 80). This attentiveness to flow and movement is fundamental to a decolonised science.

Alison’s discussion that I continue to weave into the fabric of this thesis becomes important yet again:

> I want to be floating because I feel like life is not about solid – this is the way it has to be, this is what I have to do. And I think a lot of scientists see that that is science, but that's not science. Science is about, science should be more like anthropology. It's not about okay I have a hypothesis, I must test it. Okay let's try something, someone has said this, let’s try it and let’s observe what happens. But now you do targeted sequencing, so you look for something so specific in a specific arena. It's like going into a football field,

> cordoning off the one side and looking for one specific seed, and that is where you go and do your experiment. That's not science, and people like to think that.

Alison spoke about movement ("floating") and stasis or fixity ("solid"), contrasting the two and using them to speak about how science "is" and how "science should be." In her model, science should be less about testing a hypothesis and more about observing what happens. The difference between the two is a pre-determined static, fixed and bounded way of producing knowledge versus one that is fluid and open. The former, fixed by nature, is just that, "fixed," like a match that has its winners already defined at the onset. The latter remains open to possible becomings (remaining "available," as I have discussed many times throughout this thesis). In this switch from how science is to how science should be is the understanding that science needs to be porous, it needs to be attentive and responsive to conceptualisations of flow and movement between the laboratory and the world outside of it. The laboratory need not be seen as a continuation of the idea of "empty space," discussed by Green (2020), independent from and separate to the world.

As the head of the division wrote in his email to me after my presentation at the TB clinical forum, *impactful research outside of the lab is key to whether a scientist is doing good research… I would really like to see care being the primary focus and research being the tool to demonstrate care.* This comment is precisely about understanding flow and movement, that there needs to be a connection between the laboratory and the world outside. Scientific research needs to be about impact, not about outputs that exist in empty space. This was the root of Alison's argument that scientists do not care (enough), discussed in Chapter 2. I have discussed in subsequent chapters the ways in which flow and movement existed between the laboratory and the real world. This was discussed in Chapter 4 and at length in Chapter 5. These chapters argued that science did not *just* exist in the laboratory. The way in which my participants conducted their scientific research and themselves as scientists in the world shows that scientific and personal interests flow outwards. They demonstrated that laboratories are and can be connected to the world outside of them in significant ways.

The key to decolonising science, then, is connecting the laboratory and the world outside through understanding the flows and movement between the two. This opposes the

science/society and laboratory/world binaries, namely, science existing outside of and independently of society. In Chapter 3, I argued that science is not and can never be independent of the social. Scientific research, with its particular matters of concern, is a personal and social practice. Decolonising science, therefore, means expanding the scientific matters of concern so that science and scientists "become infected by such things" (Stengers, 2018: 37). These "things" are the things that concern society (ibid). This is precisely closing the gap between the lab and society to produce knowledge that is relevant. This is how a different kind of science is grown.

GROWING A RELEVANT SCIENCE, GROWING A DECOLONISED SCIENCE, GROWING A CARING SCIENCE

As the Science Faculty Engagement meeting progressed and students were given space to articulate their views, what materialised was the sentiment that decolonisation becomes a tool for building a different kind of science in South Africa. Chikane writes, "#MustFall politics is primarily concerned with the *creation rather than the destruction* of the social infrastructure in South Africa and many of its institutions" (2018: 78-9, emphasis added). Decolonisation, therefore, is a generative practice. Early on in his book, Chikane writes, "the purpose… is not to scorch the earth but *to claim the right to plant seeds*" (2018: 32, emphasis added). Le Grange also uses this metaphor, speaking about decolonisation as "the *germination* of a different South African university" (2019: 31, emphasis added). Growth has been central to this thesis. It has been central to definitions of care, and to the continuation of scientific research through the nurturing of cells and bacteria. Growth has been central to getting used to scientific research with more than humans, and to creating environments that foster the advancement of scientists and scientific institutions. These are just some of the examples I have discussed in this thesis. Bringing the idea of growth to bear on decolonisation continues the exploration of the ways in which my research with scientists is significant in the discussion of decolonising science.

In Chapter 1, I explained how it was the slow growth rates of *Mtb* that made me think about time and the experiment, time and science, and time and care. These multiple and conflicting temporalities, or "timescapes" (Adam, 1998) helped me understand various temporal

tensions that led me to argue for slow, patient and careful science. Building on Stengers (2018) argument for slow science, slowing down is about re-thinking science as a whole in order to make it respond in ways that are relevant, impactful and careful. It is about questioning what "counts" in science, or, in other words, what science cares about. Slow science is science that is "affected" by the world in which it is embedded so that "relevance" to that world becomes the guiding force (Stengers, 2018: 42). Slowing down science urges for science to reconnect with the world in which it exists to ensure that it serves humanity rather than industry. I argued that slowing down means dissolving the science/society divide that keeps science from engaging with different thought collectives. A decolonised science is a science that *thinks together* with the community. The growth rates of *Mtb* and the resultant slow scientific research with this pathogen allowed me to explore the value in slowing down.

In Chapter 2, I showed how most of the labour inside the laboratory revolved around the growth of the cells and bacteria. Significantly, Milton Mayeroff defined care as "helping the other grow" (1971: 1). Growth is intimately tied to care. In Chapter 5, I showed how Emily wanted to care, to help other foreign African students *grow* in an environment that did not make them feel like they could grow because they were not cared for and made to feel they belonged. In a very real way, this experience shows that there needs to be care for growth to occur, weaving connections between the real need for human caring not just for other species, but for other humans. Emily connected care and growth to create an environment where scientists could "thrive" – grounding Tim Ingold's concept of "anthropogenesis" that he defines as "making-in-growing" (2015: 122). In Chapter 5, I also showed how each of my participants moved their care beyond the laboratory to help in various ways, allowing those around them to grow and thrive. In each of these examples, my participants were growing a more caring science and institution of science. They were germinating the seeds and growing the kind of science that was imagined by the students in the Science Faculty Engagement meeting. We have a lot to learn from them.

What the students in the Science Faculty Engagement meeting were calling for was a science that forms connections rather than perpetuates separation, alienation and isolation. The students wanted science to fall because it felt disconnected, out of touch with and far from their realities. The issue was precisely with the notion of science-as-apart-from-society. Or, a

science that does not connect the lab and the (African) world beyond it. The students argued for connection between the university and the community, between science and society, and between the world of academia and the world of Africans. Their argument had everything to do with relevance, which is formed by connecting the lab and the world outside of it. This is about weaving relations and connections to make relations across all sorts of real and imagined boundaries. In this argument, decolonising science has to do with growing and weaving relations and connections to allow for the emergence of a relevant science.

As I have argued throughout this thesis, care is based on connection and relation. That is precisely why care was seen as disruptive by Joan Tronto (1993) – because it pushes for a world that values interdependence rather than autonomy. The ethic of care that was developed from women's moral theory by Carol Gilligan (1982) was based on relationships rather than the individual and connection rather than separation. Care, because it is grounded in interdependence, connectedness and relationships, directly speaks to the calls for a decolonised science. Using care as a framework allows for the interrogation of what the industry of science values or "counts." As I have argued in many of the chapters of this thesis, scientists need to value those same things if they are to be successful. They need to produce particular outputs, they need to publish in high-impact journals and they need to secure funding. Rather than valuing or counting the impact – the relevance – that scientific research has in society, the parameters of success reinforce the separation between science and society. This is why the discussion of whether scientists actually care became such a prominent question. A caring science is a decolonial science. It is in touch and in tune with what matters to the world beyond the laboratory, beyond the institution. As I argued in the Introduction, if colonial thinking and doing is doing *alone*, decolonial doing and thinking is doing and thinking *together*. Decolonising science therefore involves forming relationalities and connections where they were previously severed: between science and society, scientists and the public, subjects and objects, and the laboratory and world outside of it. The themes that are central to this thesis such as care, connection, relationality, flow, movement and entanglement have become important tools for decolonising science. This highlights that science does not need to "fall." But, if it is to grow in South Africa, it needs to reconnect with the context in which it exists and the people within this context. The mutual flourishing of South African science and South African society is only possible in their reconnection.

THE SCIENTISTS WALK MORE SLOWLY: AN INCOMPLETE CONCLUSION

An excerpt from Neil Gaiman's poem *The Mushroom Hunters* (2017), which he wrote in honour of women scientists, reads (see Appendix B):

Science, as you know, my little one, is the study
of the nature and behaviour of the universe.
It's based on observation, on experiment, and measurement,
and the formulation of laws to describe the facts revealed.

In the old times, they say, the men came already fitted with brains
designed to follow flesh-beasts at a run,
to hurdle blindly into the unknown,
and then to find their way back home when lost
with a slain antelope to carry between them.
Or, on bad hunting days, nothing.

The women, who did not need to run down prey,
had brains that spotted landmarks and made paths between them
left at the thorn bush and across the scree
and look down in the bole of the half-fallen tree,
because sometimes there are mushrooms.

Before the flint club, or flint butcher's tools,
The first tool of all was a sling for the baby
to keep our hands free
and something to put the berries and the mushrooms in,
the roots and the good leaves, the seeds and the crawlers.
Then a flint pestle to smash, to crush, to grind or break.

...

The race continues. An early scientist
drew beasts upon the walls of caves
to show her children, now all fat on mushrooms
and on berries, what would be safe to hunt.

The men go running on after beasts.

The scientists walk more slowly, over to the brow of the hill
and down to the water's edge and past the place where the red clay runs.
They are carrying their babies in the slings they made,
freeing their hands to pick the mushrooms.

This poem beautifully articulates the significance of slowness. Gaiman (2017) pays homage to women's contributions to the birth of science, associating scientific discovery with a slower feminine rhythm of being in the world. "The scientists walk more slowly" is an important line in the poem. The knowledge that comes from slowing down – from walking rather than running, from calculating rather than following blindly – is the difference between life and death, between returning from hunts or not, between eating mushrooms that kill or eating mushrooms that nourish. Slowing down allows for navigating the landscape, making pathways and connections that are not noticeable at fast pace. Slowing down allows the small things to be revealed, such as the mushrooms and berries that will provide sustenance. Gaiman (2017) communicates how scientific knowledge is made in the slowness, not in the race to hunt, but in the picking of berries and mushrooms and the observations of their effects. This is the temporal rhythm that Maria Puig de la Bellacasa (2017) has defined as "care time" and it runs counter to what I have called "scientific time"– the fast-paced, highly productive, publish-centric, "swim or sink" world of science.

Like the mushroom hunters, my participants operated at a different temporality. This was not just because scientific research with *Mycobacterium tuberculosis* was slow research owing to the bacteria's slow growth rates. This was because slower temporalities were more aligned with how they wanted to be in the world and conduct both their lives and their science. What they cared about was not necessarily what mattered in the fast-paced world of science, such as publications. Like the mushroom hunters with their babies in slings, my participants were carers. Their care took many forms. They cared for bacteria, cells and mice inside the laboratory as well as humans beyond the laboratory. They cared about students and colleagues as well as communities. They cared about women scientists and foreign African students as well as wild rhinos and lions. They cared about creating inclusive scientific institutions as well as being part of community engagement projects. They cared about patients in the clinic as well as creating change at the institutional level. Most of all, they cared about helping others grow and thrive, whether humans or more than humans.

In this thesis, I have argued for the importance of care in science and what an ethic and philosophy of care could mean for science. Puig de la Bellacasa writes about ethics, "In other words, ethics is a personal affair but one that is only noble insofar as it aspires to leave a mark

in a collective– that is, a polis” (2017: 134). The ethic of care from my participants that has been made clear in this thesis indeed aspired to be a part of something bigger and of greater social significance. Within the caring that I observed in the laboratory and beyond, I observed a very significant scientific practice. My participants challenged the idea that scientists are disconnected from the world outside the laboratory. They were all deeply touched by what they did, creating spaces of caring that navigated tendencies in science for objective distance and detachment. This had nothing to do with experimental bias or tampering with the experimental system. This had everything to do with caring that connected across the researcher/researched, lab/world and science/society boundaries. In fact, this is what made for better and more careful and caring scientists. I offer these shifts, which manifested in attitudes as well as practices of connection, to act as guides in growing a decolonised science.

Since interdependence, connection and relationships are central to care – as each of the chapters in this thesis argued – a caring science is a science that is in touch with the society in which it exists so that it is driven by what that society needs and cares about. The result is the creation of a more caring science and institutions of science that are sensitive, available and connected to scientists, humanity and the environment. It would be a science whose “matters of concern” (Latour, 2004) encompass the concerns of greater collectives so that it is in service not just of the industry of science, but the betterment of humanity. “Standing by the vital necessity of care means standing for sustainable and flourishing relations, not merely survivalist or instrumental ones,” Puig de la Bellacasa writes (2017: 70). Standing for care in science means standing for the mutual flourishing of both science and African society. It was, after all, *relevance* and *connection* to African worlds that the University of Cape Town students were calling for in their discussion on decolonising science (see Schulz, 2016). Relevance to African society, they argued, needs to be at the foundation of scientific exploration and innovation in Africa. A decolonised science is a caring science that weaves the laboratory and the world in which it is embedded in relevant, meaningful, responsive and impactful ways.

The narratives of care that I have described from the laboratory and beyond it, highlight that scientific research is deeply personal, and that the natural and the social are intimately woven together. This complicates critiques, such as those from decolonial poet and scholar Aimé

Césaire, who wrote that "Scientific knowledge is a lion without antelopes and without zebras. It is gnawed from within. Gnawed by hunger, the hunger of feeling, the hunger of life" (1982: 18). I hope that this thesis has shown otherwise. If there is a single thread that is carried home after this is read, it should be that scientific research is deeply personal, emotional and caring. Scientists are intimately involved in the production of facts, as Chapter 3 "Science and the Body" makes clear. Their hearts enter into the experiment. This does not make their science any less excellent. In fact, this adds richness and texture that makes for more profound science. Or, as Leigh noted, this makes "a better, more careful researcher." This is particularly important for scientific research that understands it has the potential to be of service. My time with my participants taught me that "too much sway has been given to critique and not enough to seeing what else is going on… and what else is needed" (Haraway, 2008: 74). I learned that so much more goes on in scientific research, both within the experiment itself, within the research project and beyond the research project. The "behind the scenes" of science is rich with care. It is about time we start acknowledging this to learn how to move forward in this particular socio-political moment as we confront and interrogate our colonial heritage.

While this may feel like a conclusion, it is far from it. This ethnographic research was just one snapshot of the work-lives of my participants. It is by no means finished or complete. The scientists with whom I worked were far more dynamic, far more nuanced, far more multifaceted. They have many more stories and experiences, more than I could ever fit into this thesis. I have sincere and exhaustive admiration and respect for them and the work they did. It is because of this that I will never be able to do justice to these incredible scientists and their work. The months that I spent in the field and the years that I have spent on this research could never feel enough. Ingold writes, "To do anthropology… is to dream like an Ojibwa. As in a dream, it is continually to *open up* the world, rather than to seek closure" (2008: 84, original emphasis). This thesis is a small contribution to that opening up, with a deep understanding that there will never be closure. I am writing about some of what mattered, of course, there was so much more. I am showing some of what my participants cared about, of course, they cared about so much more.

Clifford Geertz famously wrote:

> Cultural analysis is intrinsically incomplete. And, worse than that, the more deeply it goes the less complete it is. It is a strange science whose most telling assertions are its most tremulously based, in which to get somewhere with the matter at hand is to intensify the suspicion, both your own and that of others, that you are not quite getting it right (1973: 29).

I read these sentences in my undergraduate courses in anthropology, but only when I started conducting this ethnographic research did I begin to understand what they meant. The more I learn, the more I realise there is still so much to learn. The more I write, the more I feel I am not quite getting it right. Stories are never complete. Ethnography is never complete. Theory is never complete.

Francis Nyamnjoh has written on incompleteness, arguing that "incompleteness is the normal order of things" (2017: 262). He calls for "conviviality" in the face of incompleteness, defining conviviality as "recognition and provision for the fact or reality of being incomplete" (ibid). Recognising this research is incomplete means recognising that there will always be gaps. This thesis does not (and cannot) address all the areas of scholarship that it touches on. While I have tried to include what I believe is important to understanding the main arguments, there are indeed many gaps. Clifford writes about culture, "There is no whole picture that can be 'filled in,' since the perception and filling of a gap lead to the awareness of other gaps" (1986: 18). In Chapter 1 "Weaving Methodology and Ethics," I argued that gaps are not times and spaces of nothingness, or emptiness. They are active time-spaces, that allow "room" for much to occur. Gaps are significant. They leave space.

The gaps humble me, because I could never claim to be an expert on everything (or anything). For Nyamnjoh, "conviviality invites us to celebrate and preserve incompleteness and mitigate the delusions of grandeur that come with ambitions and claims of completeness" (2017: 262). Incompleteness is, therefore, not a weakness, but a strength. It leaves space for others to join, it calls for a collective, it asks for thinking *together*. As Nyamnjoh writes, "Conviviality encourages us to reach out, encounter and explore ways of enhancing or complementing ourselves with the added possibilities of potency brought our way by the incompleteness of others" (2017: 262). But not as "a ploy to becoming complete (an extravagant illusion

ultimately)" (Nyamnjoh, 2017: 262). Conviviality, or what Nyamnjoh calls "convivial scholarship" (2017: 266), is about being *together*. Therefore, this *salaula* mat, tapestry, or sociable weaver nest is one among many. This means that it can grow bigger with more additions, more weaving.

APPENDIX A – THE SLOW SCIENCE MANIFESTO

"The Slow Science Manifesto" published in 2010 by The Slow Science Academy in Berlin:

We are scientists. We don't blog. We don't twitter. We take our time.

Don't get us wrong—we do say yes to the accelerated science of the early 21st century. We say yes to the constant flow of peer-review journal publications and their impact; we say yes to science blogs and media & PR necessities; we say yes to increasing specialization and diversification in all disciplines. We also say yes to research feeding back into health care and future prosperity. All of us are in this game, too.

However, we maintain that this cannot be all. Science needs time to think. Science needs time to read, and time to fail. Science does not always know what it might be at right now. Science develops unsteadily, with jerky moves and unpredictable leaps forward—at the same time, however, it creeps about on a very slow time scale, for which there must be room and to which justice must be done.

Slow science was pretty much the only science conceivable for hundreds of years; today, we argue, it deserves revival and needs protection. Society should give scientists the time they need, but more importantly, scientists must *take* their time.

We do need time to think. We do need time to digest. We do need time to misunderstand each other, especially when fostering lost dialogue between humanities and natural sciences. We cannot continuously tell you what our science means; what it will be good for; because we simply don't know yet. Science needs time.

—Bear with us, while we think.

APPENDIX B – *THE MUSHROOM HUNTERS* BY NEIL GAIMAN

Science, as you know, my little one, is the study
of the nature and behaviour of the universe.
It's based on observation, on experiment, and measurement,
and the formulation of laws to describe the facts revealed.

In the old times, they say, the men came already fitted with brains
designed to follow flesh-beasts at a run,
to hurdle blindly into the unknown,
and then to find their way back home when lost
with a slain antelope to carry between them.
Or, on bad hunting days, nothing.

The women, who did not need to run down prey,
had brains that spotted landmarks and made paths between them
left at the thorn bush and across the scree
and look down in the bole of the half-fallen tree,
because sometimes there are mushrooms.

Before the flint club, or flint butcher's tools,
The first tool of all was a sling for the baby
to keep our hands free
and something to put the berries and the mushrooms in,
the roots and the good leaves, the seeds and the crawlers.
Then a flint pestle to smash, to crush, to grind or break.

And sometimes men chased the beasts
into the deep woods,
and never came back.

Some mushrooms will kill you,
while some will show you gods
and some will feed the hunger in our bellies. Identify.
Others will kill us if we eat them raw,
and kill us again if we cook them once,
but if we boil them up in spring water, and pour the water away,

and then boil them once more, and pour the water away,
only then can we eat them safely. Observe.

Observe childbirth, measure the swell of bellies and the shape of breasts,
and through experience discover how to bring babies safely into the world.

Observe everything.

And the mushroom hunters walk the ways they walk
and watch the world, and see what they observe.
And some of them would thrive and lick their lips,
While others clutched their stomachs and expired.
So laws are made and handed down on what is safe. Formulate.

The tools we make to build our lives:
our clothes, our food, our path home…
all these things we base on observation,
on experiment, on measurement, on truth.

And science, you remember, is the study
of the nature and behaviour of the universe,
based on observation, experiment, and measurement,
and the formulation of laws to describe these facts.

The race continues. An early scientist
drew beasts upon the walls of caves
to show her children, now all fat on mushrooms
and on berries, what would be safe to hunt.

The men go running on after beasts.

The scientists walk more slowly, over to the brow of the hill
and down to the water's edge and past the place where the red clay runs.
They are carrying their babies in the slings they made,
freeing their hands to pick the mushrooms.

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