

The Information Practices of Scientists: Zooming into Microbiologists' Domains of Interaction

by Giovanni Eduardo Forero Parra

Thesis submitted in fulfilment of the requirements for
the degree of

Doctor of Philosophy

under the supervision of
Dr. Hilary Yerbury and Dr. Timothy Laurie

University of Technology Sydney
Faculty of Design and Society

April 2026

CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Giovanni Forero, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Design and Society at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research was supported by an Australian Government Research Training Program (RTP) Scholarship doi.org/10.82133/C42F-K220.

Signature: Production Note:
 Signature removed prior to publication.

Date: 23 April 2026

ACKNOWLEDGEMENTS

The labour involved in doctoral research is a rewarding and exciting experience but is also one that is long and requires a great level of commitment and persistence. During this process I was confronted with the reasons and motivations that made that first commitment necessary. And as I have learned from my research, one is not only a researcher, but a person moving through life and circumstances, and it could be those external factors that could weaken that first commitment if it were not for those that encouraged, challenged and reminded me at every step of the way to keep looking at the bigger picture.

First and foremost, my wife, who has been my absolute rock. She has been not only the partner of my life but my greatest friend, the person who encouraged me, who challenged me and reminded me why it was important to push a little bit more. She has not only been a supporter, but she also paid the greater price. She has made everything possible in practical ways to make sure that I had the spaces and the time to make this project a reality; she shouldered a greater burden because of her commitment to me. To my greatest love, this work is the result of your support, and it would have been impossible without you.

To my two boys, who are my greatest reason in almost everything in my life, your presence, patience and love have been my greatest engine. I know how many times you have supported me by allowing me to study rather than having fun and have grown up watching me on the computer always working on something. Yet you have always been gracious and provided me with the fuel needed to continue.

To my friends and colleagues who through all these years have inquired about my progress and have always been patient when I have had to excuse myself to finish a draft or to study. I am totally convinced that life without friends is a life half-way lived, and your support has been part of my accomplishment.

This project, of course, would not have been possible without the participation of Professor Karen and her team of scientists who willingly decided to contribute

to this research. I am so grateful for their time and participation, for their incredible patience, candour and the time they took to explain, demonstrate and let me be part of their world for a period of time. It was a privilege to know them and to have a window into their world and to observe the passion with which they practise their scientific tasks.

I want to thank Dr. Timothy Laurie, my co-supervisor, who came late to the supervision team, and whose willingness to review my texts and provide sound and focussed advice has been invaluable for this project. I am also grateful for his guidance as School Coordinator of HDR students in navigating the rules and requirements; this has been very important in bringing this study to completion.

I express my gratitude also to Dr. Michael Olsson, who has been my professor and mentor since I started my Masters, and my supervisor during the first stages of my PhD, and who has continued to support me and advise me throughout this process in the most selfless manner, providing positive observations, guiding me and also providing encouragement at times when I most needed it.

I would also like to acknowledge the incredible support of Dr. Hilary Yerbury, my principal supervisor, who has been paramount for this thesis to be finished. Her dedication, support, patience, guidance, positive criticism, has been fundamental for this gigantic work to be completed. Her feedback, but more than anything her constant follow up and knowledge, have been an intellectual gain for this thesis and for me, and without her unparalleled support this thesis would not have reached its final stages.

And to my Lord, without whom I would not be able to believe that there is something greater than myself that makes any effort worthwhile in the greater scheme of things. To all of those mentioned here who have contributed, supported me and encouraged me, I would like to acknowledge and thank you. Without you this project would not have been completed.

Giovanni Forero
April 2026

COVID-19 IMPACT STATEMENT

The closure of schools and disruption of the work and family routines had a direct effect on my time availability and agenda, having to divert a large portion of my time to be divided between my full-time work and my children's' education and the demands of School at Home. This in turn impacted the time I had available to devote to the analysis of the data collected throughout my investigation, leaving me with little time for doctoral work and turning upside-down my timetable for completion of the thesis. After the Covid-19 restrictions were removed, it took a while to re-establish an effective work and study pattern.

TABLE OF CONTENTS

CERTIFICATE OF ORIGINAL AUTHORSHIP	ii
ACKNOWLEDGEMENTS	iii
COVID-19 IMPACT STATEMENT	v
ABSTRACT	xi
CHAPTER 1: INTRODUCTION	1
A Journey of Discovery	1
The Significance of the Study	9
Structure of the Thesis	13
Conclusion.....	16
CHAPTER 2: LITERATURE REVIEW	18
Introduction.....	18
Information Practices.....	20
Context in Information Practices	22
Information Practices in Everyday Life.....	24
Embodiment in Information Practices	26
Affect in Information Practices	28
Scientists and their Use of Information	29
Practice Theory	39
Embodiment in Schatzki's Practice Theory.....	42
Affect in Schatzki's Practice Theory.....	44
Site Ontology in Schatzki's Practice Theory	46
Latour's Conceptualisation of Site	49
Horton's Cosmic Zoom - Moving Across Sites.....	51

Science and Technology Studies	55
Latour and Actor-Network-Theory (ANT)	56
Knorr-Cetina and Her Epistemic Cultures	60
Pickering and His Dance of Agency	64
Haider and Kjellberg and Preserving Objects as Data through Time	67
Antonie van Leeuwenhoek and Observation	68
Conclusion	69
CHAPTER 3: METHODOLOGY	72
Introduction	72
Choosing a Research Methodology	73
Choosing Ethnography	74
Ethnography in Other Studies	82
Putting Ethnography into Practice	85
Accessing the Research Culture	86
Data Collection	87
Immersion Into the Culture	88
Observing the Scientists and Their Environment	88
Interviewing Participants	90
Taking Fieldnotes	91
Gathering Documentation	92
Data Analysis	94
Content Analysis	94
The Cosmic Zoom as an Analytical Tool	97
Ensuring Quality in the Study	98
Being a Participant Observer	99

Preserving Memories and Impressions – Quality in Fieldnotes	100
Quality in Data from Observations and Interviews	101
Value in the Documents.....	102
Ensuring Quality in Analysis	103
Ethics Approval.....	105
Conclusion.....	107
CHAPTER 4: FINDINGS.....	109
Introduction.....	109
Getting to Know the Context.....	110
Science as System of Practice	111
The Actors	112
Entering the Biological Laboratory	122
The Information Practices of Scientists	127
Using Information and Creating Knowledge.....	127
Reporting the Information Practices of Scientists	139
Living in Other Domains.....	174
The Ethnographer's Experience	185
Conclusion.....	190
CHAPTER 5: DISCUSSION	192
Introduction.....	192
Contributions to Information Practices Research	192
Creating an Epistemic Culture	193
The Localised Epistemic Culture of this Group of Scientists.....	199
The Information Practices of Scientists.....	203
An Innovative Analytical Approach to Information Practices Research	211

The Cosmic Zoom & Domains of Interactions.....	211
An Innovative Approach to Methodology	218
On Writing Ethnographic Accounts	219
On the Practices of the Ethnographer	226
Conclusion.....	230
CHAPTER 6: CONCLUSION	232
Introduction.....	232
Summarising the Study	232
Implications for Further Research	236
On Methodology	236
On Information Practices	238
Implications for Professional Practice.....	240
Study Limitations	242
Concluding Remarks	243
BIBLIOGRAPHY	245
APPENDICES.....	256
Appendix 1 – Interview Protocol.....	256
Appendix 2 – Consent for Recording the Session	257

TABLE OF FIGURES

Figure 1: Laboratory Floor Plan (source: Fieldnotes, 2018).....	123
Figure 2: The Buffer Zone Detail (source: Fieldnotes, 2018)	140

ABSTRACT

This study examines the information practices of a group of scientists in a university-based laboratory. It takes a Practice Theoretical approach influenced by Schatzki (2002) and draws on Actor Network Theory to provide a conceptual framework to understand the social dynamics, interactions and information practices of these scientists.

The research uses ethnography as its methodology, bringing innovations not common in information practices' research. Acknowledging the position of the ethnographer as fieldworker, outside of the interactions being observed, but also as a participant within the social environment being investigated, the findings are written in both third person and first-person voices, in the form of vignettes, following Van Maanen (2011).

The innovative adaptation of the concept of the Cosmic Zoom (Horton, 2021; McKenzie, 2022) as an analytical tool uncovers the complexity of the information practices of these scientists, going beyond the embodiment practices and affect identified in the localised focus of much information practices research. The use of this analytical tool reveals a dynamic environment; scientists interact with other actors, including non-humans, in multiple domains simultaneously, sometimes outside the confines of the laboratory while they work at the bench. The findings document these interactions, identifying in particular the importance of observation, storytelling and the use of a localised discourse as key components of information practices for scientists.

The concept of Domains of Interaction is presented to encapsulate a key finding, that sometimes scientists' agency in the laboratory is central to their relationships, while at other times in other domains, their agency is peripheral and they are subject to the circumstances that exist in another domain. This is a way to counter Latour's assertion that relationships in a scientific laboratory could be conceptualised as existing only in one plane.

The writing of the ethnographic account shows how, behind the lives of the scientists carrying out their scientific practices, other versions of their lives were present, affecting their information practices. The use of the Latin-American literary style called Marvellous Realism, typically known as Magical Realism, enabled potential hidden dimensions of their lives to be documented.

This study offers new ways to think about information practices, especially in scientific contexts, as the consolidation of multiple domains of interaction acting on the site. The interactions between the scientists and the instruments they use, have implications for professional practice, as technologies are increasingly presented as partners in the workplace. Further research can explore the appropriateness of the Cosmic Zoom as an analytical tool and the robustness of the concept of Domains of Interaction.

CHAPTER 1: INTRODUCTION

The introduction to this thesis displays aspects of my journey and conceptual development from a curious engineer working as a consultant in the field of information management to doctoral researcher who has explored the question: **what are the information practices of a group of scientists working in a university laboratory?** In beginning with my journey, I reflect on my development as the ethnographer of this study. The journey has been full of twists and turns that have contributed to the evolution of my own understanding as particular aspects of the completed investigation emerged. This chapter presents the significance of this study. It reflects briefly on the literature of Information Practices and specific focal aspects in its development. It sets out what I saw as a narrowness in that literature (Huvila & Gorichanaz, 2025), There is little literature on Information Practices, with a decreasing concern with information practices in the workplace. There are very few studies of laboratory-based scientists, Thus, there is an obvious gap for this study to fill. However, my interest is also in the conceptual underpinnings of research into the use of information and creation of new knowledge. To remedy what I see as weaknesses in this literature, I have emphasised the importance of aspects of embodiment and affect, and of using a methodology that goes beyond interviews. I also have indicated how I have created a stronger conceptual frame for my study, bringing in conceptual framings from outside of Information Practices. I The chapter concludes with an overview of the structure of the thesis, setting the scene for the rest of the study.

A Journey of Discovery

I have always been impressed by the prominence that information, as an idea, holds in our society, how ubiquitous the concept seems to be, how difficult to define and how fundamental it is for our own understanding of the world. My curiosity was sparked when I was studying engineering during my undergraduate degree some years ago in Colombia. That interest only

flourished further as I became an information management consultant in the United States of America, helping organisations and individuals to improve their information management practices via technology. However, it was not until I started studying for a master's degree in information and knowledge management at the University of Technology Sydney, here in Australia, that I appreciated that there was a significant conceptual dimension to understanding information and its use. In a class called People, Information and Knowledge, one of the required readings was Michael K. Buckland's (1991) paper "Information as Thing". This paper had a critical impact on me. Up to that moment, the concept of information was always something rooted in the private intellectual capacity of human beings to understand their world and only exchanged across human minds; objects were, at most, only containers of information suspended on the backdrop of human reality. Reading Buckland's article, back then, expanded my thinking, forcing me to consider if and how information processes could be identified in many other ways beyond the cognitive paradigm.

Buckland's article was however the first stepping stone of a journey that has now taken me several years from that first class in my masters' degree. Even though it produced an undeniable effect on my thinking, it did not satisfy my pursuit for understanding fully the processes I was working with professionally. Nor did the ideas in it seem robust enough to support a doctoral study. The conceptual approach of Information Behaviour left me discontented, as it gives the impression of a linear process that revolves around information needs, triggers and behaviours (Belkin, 1990), but has a big black box in the middle, the private mental states of the individuals, which needless to say cannot be opened.

In that regard, the Information Practices approach proposed by scholars such as McKenzie (2003), Savolainen (2007), Lloyd (2010) and Olsson (2010; 2016), provided me with a better alternative to explain how a group of scientists, in agreement or by the force of their circumstances, enact and constitute information practices in social contexts by which they achieve common goals,

such as the production of academic and scientific knowledge. Here, there is no relying on interpreting behavioural cues to decipher cognitive paradigms. Rather, I saw in this approach a set of possibilities for interacting with the site, observing their interactions and thus, their information practices, and from this to have a solid empirical basis for understanding how this local culture produces knowledge.

Information practices research, in seeking to understand our relationship with information as embedded in social practices, have often drawn on theoretical and methodological practices from other disciplines, opening up a much broader range of possibilities for the present study. Olsson's study of archaeologists in the field, for example, drew on a range of different conceptual (Dervin's Sense-Making and Foucauldian ideas) and methodological approaches, such as ethnographic fieldwork, to show that participants' information practices were both social and embodied in nature" (Olsson, 2016, p.410; Cox, 2018; Cox and Fulton, 2022), And Lloyd (2010), provides another instance, engaging with Schatzki's Practice Theory and his site ontology to frame information literacy as information practice. Hence, Information Practices provides the theoretical underpinning of this investigation and is the basis of my research question. Its adoption as a guiding conceptual framework helped me to include in my observations the social, embodied, and affective capacities of the scientists who took part in the study. These information practices were expressed in the way they interacted with their instrumentation and the circumstances of their environment, both inside and outside the laboratory.

However, a large amount of the published research studies in Information Practices may not necessarily recognise how emotive and bodily postures and reactions may be in response to non-human actors, although, I was not able to articulate it at that moment, my professional training and development had led me to accept a world in which material agency has a shaping effect on the contours of a social environment. For a while, my taken-for-granted practice-based approach to interactions may have prevented me from understanding, at

a deeper conceptual level, the ontological positions of the scholars whose work I was reading.

As a masters' student, my curiosity for the subject led me to read widely and through this to obtain a deeper understanding of how people engage with information and information structures in multiple settings. Such appetite for reading and discovery went beyond the recommended reading list for my course and allowed me to start from Information Science in general and Information Practices in particular and move to a more interdisciplinary exploration in sociology that has shaped by my own interests as an engineer and my professional practice implementing information solutions.

In what was really reading for pleasure, it was undeniable that my training in engineering gave me a background that allowed me to understand the material aspects of the social environment which are commonly neglected, such as the role of technology and non-human actors in Information Practices. In this sense I owe a debt to Latour's (2005) Actor Network Theory (ANT) that permitted me to make sense in a more sophisticated way of how the social environment could be populated by participants, both human and non-human.

The tools offered by Latour's (2005) ANT provided a conceptual foundation to understand agency in a site, but this understanding was further strengthened in my reading early in my doctoral studies of Schatzki's *The Site of the Social* (2002), as well as papers by other authors in Information Practice who have also used Schatzki's Practice Theory as a conceptual framework, such as Lloyd (2010). I could envisage how my own study might benefit if ANT and Practice Theory were used as a hybrid conceptual framework. I recognised this was not a common choice in research studies of Information Practices, that counting some exceptions such as Pilerot (2014a), Ekström (2024a), Gullbekk (2021) that engage with these ideas in some capacity, these two frameworks do not seem to have been used together as a hybrid approach, nevertheless, they seem to be complementary approaches. I understood how together they could provide my proposed doctoral study with a strong foundation to understand the

social context and the site, opening the possibilities of analysis of Information Practices, beyond human actors and beyond the understanding of locality usually found in Information Practices research, allowing me to surpass the physical site to account in my research for other domains where some of the seeds of the group's information practices could be found, but that are often not taken into account as being directly related to the information practices being investigated (Pilerot, 2014a, p.22).

Once I began my doctoral study, with its focus on the information practices of scientists, I immediately recognised the value for my investigation of my earlier reading of Latour and Woolgar's book, *Laboratory Life* (1986). Its importance sprang not only from the ANT perspective, but also because it served as an example of ethnography, and the role of the observer within a scientific laboratory was critical both to the study and to my emerging understanding. Such was the case as well for Knorr-Cetina's *Epistemic Cultures* (1999) that also became a model of how to employ ethnography in a scientific laboratory and to understand the impact of technology for the production of knowledge.

Other early reading included Pickering's *The Mangle of Practice* (1995) and to a certain extent *Constructing Quarks* (1984). His unconventional and historical approach allowed me to understand the interaction of scientists with technology and to a greater measure non-human actors within the laboratory, as a process of fine tuning of practices as scientists attempt to manipulate the instrumentation to obtain the results that would advance their discoveries. It also emphasised the importance of social interactions and convention in the acceptance of scientific knowledge.

As I reflect on this early reading, I can see that my interest leant towards the way these authors explored the relationships between humans and machines, in other words, the material aspects of Information Practices. At the time, I was unaware that my reading largely belonged to a literature labelled Science and Technology Studies (STS), but I sensed synergy between the required readings on Information Practices in my masters' program and STS. This early cross-

over was beneficial for my doctoral investigation as I sought to establish the conceptual links between the two.

I was attracted to the idea of being able to adopt the approach of existing studies, but I was soon to learn that what might seem appealing as an idea in a study may not match my experience. The preparation for the introductory meeting with the leader of the laboratory, where I was hoping to carry out my ethnographic study, made me begin to question a key aspect of ANT. As the date for the meeting grew nearer, I felt more and more excited and anxious about meeting the leader of the laboratory, who I admire. This was not the kind of dispassionate interaction that ANT had portrayed, but I was certain it was an affective experience for me. The meeting itself showed me the importance of the social in the interactions; in other words, I recognised that interactions were not only transactional, but they could also carry an emotive dimension to them.

Thus, through this journey, my thinking has evolved from those first insights in which I questioned my original assumptions about information, to a more robust understanding of how individuals belonging to social groups accommodate their information practices as they dynamically and constantly interact in their complex daily lives. During this journey I have been able to stretch my pre-conceptions, interact with ideas, try some and disregard most, as I attempted to make sense of a foreign culture, that of the scientists, and to understand the marvellous ways in which this group of scientists record and share information and construct new knowledge.

I came to understand early on in my doctoral studies that implementing the methodology of ethnography for a study of information practices was not the transactional process that textbooks in research methods might seem to convey. Here, and also due to a lack of literature on Information Practices examining the information practices of scientists at the laboratory (Huvila & Gorichanaz, 2025), I leaned on the seminal work of Latour and Woolgar's *Laboratory Life* and Knorr-Cetina's *Epistemic Cultures* did provide exemplars of

ethnography that were useful for my understanding of how to carry out a study of scientists at work in their laboratory.

In this study, the reader will encounter a group of scientists during the course of their scientific work, not as cold, dry and unidimensional intellectual beings, but as multi-faceted individuals living across multiple domains, interacting, making relationships and adapting their information practices to whatever circumstances are thrown at them, fine-tuning their hypotheses and intertwining with multiple dimensions of their persona, across multiple sites where they interact.

What we are about to embark on, through this study, is an examination of how knowledge is established through a delicate balance of information practices, evident not only in the laboratory and informed by the methods of scientific investigation, but also in the complex and dynamic social environment where humans strive to make sense of their world. Here, I was influenced in part by Knorr-Cetina's work, *Epistemic Cultures* (1999), and her emphasis on the existence of local cultures, specifically in how she describes how each culture creates their own knowledge machineries in their creation of knowledge. I was keen to see the parallels with how another group of scientists constituted their own information practices during their investigations. Through this investigation we will see how a group of scientists use their whole human capacity, their intellectual, corporeal and affective dimensions to interact, make relationships, adapt, respond and navigate their circumstances and relationships with other actors, humans and non-human.

The implementation of ethnography as a methodological approach for my study gave me the opportunity to dive into another culture to observe the people and learn from them and try to tease out the different aspects of their information practices; it also made me reflect on my own information practices and brought the focus on myself as a nascent ethnographer, and what I was doing to be able to develop insights from the site and the people I was observing. The standard approach to analysis in ethnography as found in most studies in Information

Practices, a thematic content analysis, left me dissatisfied with the outcome, as it did not allow me to follow the scientists wherever they went. The more I interacted with them, the more it became obvious to me that they were not scientists wearing the goggles and white coats all the time, they brought other aspects of their persona to bear in the technical descriptions of their investigations. What was I supposed to do with this data, I wondered. The scientists were clearly physically present, they did not leave the laboratory, but in the ethnographic interviews and observations, they often took me outside of the walls of the laboratory. I struggled to find ways to encode facets of their accounts that seemed at times to be relevant to their practices but were not directly related to their everyday work.

It was some time after the preliminary analysis of data that I was introduced to the idea of the Cosmic Zoom through a keynote address by Professor Pamela McKenzie (2022) and read Horton's book *The Cosmic Zoom: Scale, Knowledge and Mediation* (2021). Here, again, I was attracted to the technical, to what happens in processes of zooming in and zooming out; this was what I saw the scientists doing in their observations, at one level, but I also understood the process metaphorically. Using the Cosmic Zoom as an analytical tool, I soon saw, allowed me to demonstrate how the people who are the focus of my study, central to our interactions, can present themselves as peripheral, from time to time, to aspects of their own lives, appearing to exist in some other dimension. Having identified the existence of these other dimensions, I named the concept Domains of Interaction, to denominate those other sites where participants also have connections that affect them.

My journey of learning to be a researcher continued. I had to confront that the writing of ethnography was not like writing a technical document in my professional life. Working through the data and how to express my findings, I found that Van Maanen's *Tales of the Field: On Writing Ethnography* (2011) offered me useful advice, reminding me that in ethnography, the fieldworker leaves unavoidable footprints on the reality he is experiencing, in his attempt to interpret the social dynamics of the culture he is observing. Even more useful

though was his observation that the fieldworker can adopt a literary style to present his interpretation. Thus, I adopted the use of a literary style familiar to me from my cultural background, the South American literary school Magical Realism or Marvellous Realism, one of whose major proponents is the famous Colombian novelist, Gabriel García Márquez. I prefer however, to use the term Marvellous Realism through this work, following Alejandro Carpentier nomenclature “Lo real maravilloso Americano”, “The marvellous American reality” (Roh, 1925; Slemon, 1988; Taussig, 1992), and to dispel any suspicion of the fictional or fantastic. Through writing vignettes in the descriptive process of this style, I was able to bring to light the realities of participating scientists that lay behind their scientific persona and activities.

In this way, with the use of the analytical tool of Cosmic Zoom and the use of Marvellous Realism as narrative tool to highlight the hidden or less apparent realities of scientist through vignettes, I have been able to go beyond the conventional localised conceptions of Information Practices research, with their focus on human social interaction, proposing instead a multidimensional and reticulated net of human and non-human actors and domains continuously communicating and influencing each other, co-creating knowledge and producing change across time and space. This investigation unveils the theatre of socially constructed information practices of scientists as they engage in their investigations with all their cognitive capacity, but also their bodies and emotions, while interacting with other circumstances, shaping and being shaped by multiple actors in the process, including, as we will see, the microscope, the bacteria as their object of study.

The Significance of the Study

This study will add to the relatively few studies of the information behaviours and even fewer of Information Practices that specifically focused on laboratory based scientists (cf Palmer, 1991; Hemminger et al., 2007; Palmer et al., 2009; Haines et al., 2010; Sahu & Singh, 2013; Pilerot, 2014a; Roos, 2015; Haider & Kjellberg, 2016; Nirmala & Divyananda, 2018; Gullbekk, 2021; Gordon et al.,

2022; Devi & Lawanda, 2023; Ekström, 2024a; Igbinovia et al., 2025). It also contributes to the dialogue with Science and Technology Studies (STS) (Van House, 2004; Palmer & Cragin, 2008), a fruitful outcome as there are commonalities in both fields of study. The research seeks to confirm the concept of epistemic cultures identified by Knorr-Cetina (1999) extending its implications to forces outside the laboratory that have impact on the information practices and local epistemic culture. Importantly, it will provide insights into the ways scientists in the 21st century engage with the technologies and other non-human actors that are part of contemporary scientific practices. This will allow comparison with the conceptual framework of Woolgar and Latour (1986), whose work highlighted the role of both human and non-human actors in information practices and has increasingly influenced information science research (Van House, 2004; Palmer & Cragin, 2008; Pilerot, 2014b; Kwon, 2017; Gullbekk, 2021; Ekström, 2024b). An analysis of the ways in which scientists go about the process of producing scientific papers may provide a useful comparison with the processes identified by Woolgar and Latour (1986) and shed light on the role of the development of scientific knowledge in a contemporary scientific laboratory.

The significance of the opportunity to conduct the study in a university-based scientific laboratory is worth mentioning. The extensive literature on Information Behaviour displays a long tradition of research on scientists' needs and behaviours, but when it comes to scientists doing science in the laboratory, this type of research is limited from both an Information Behaviour and an Information Practices perspective (Jones, 2005; Research Information Network, 2009; Huvila & Gorichanaz, 2025). Gaining access for this kind of study to scientific laboratories can be difficult. By their very nature, scientific laboratories are often engaged in ground-breaking research, and therefore the opportunities for outsiders to engage with the scientists as they carry out their work are likely to be limited and constrained (Peerbaye & Vinck, 2025). This was the case for the terms and conditions under which this study could be carried out. The university's Human Research Ethics Committee gave permission for the study to be conducted (ETH17-1639), in such a way that neither the laboratory nor the

scientists were identifiable, and that details of the scientific work, beyond those already publicly available, were not revealed.

The study is consistent with the Everyday Life Information Seeking (ELIS) frameworks developed by Savolainen (1995, 2008) and McKenzie (2003), which have significantly contributed to understanding information seeking as an ongoing, integrated activity rather than a compartmentalised one (Huvila, 2008, Lloyd, 2009; Lloyd, 2010; Olsson, 2010; Pilerot, 2014a; Olsson, 2016). This research demonstrates that the participating scientists engage in information practices beyond their workplace or academic roles, highlighting a distinct separation between their professional and personal spheres does not exist (Savolainen, 1995, 2008). This study adds to the limited literature that applies the ELIS conceptualisation to scholars including scientists (Pilerot, 2014b), however this study specifically focuses on scientists doing research in a laboratory. As a consequence, the study shows that the practices of the group of scientists participating in the study do not occur in a scientific vacuum but are informed and affected by other social sites where the participants also live and interact with other actors. This perspective challenges the perspective that the work of the scientists in the laboratory is removed from everyday life (Savolainen & Thomson, 2022, p.521; Savolainen, 2023, P.940). Thus, this study will make a significant contribution to the literature, adding to the conceptual position expressed by Savolainen (1995; 2008), Savolainen and Thomson (2022) and McKenzie (2003). It shows that scientists performing the scientific method in the laboratory blur the boundaries of professional and personal life to implement information practices across multiple areas and domains. Their social interactions and approaches to everyday situations are meaningful and important, and not merely incidental, because they represent how other domains, mundane as they may be, are important in the development of information practices.

The approach this study takes to Information Practices in the context of the broader practice theoretical approach is also significant. In the Australian educational and research context, Lloyd introduced the Schatzkian approach of

Practice Theory and emphasised the importance of embodied information practices in the training of firefighters (2007) and ambulance officers (2009). In these cornerstone papers embodied information practices are those where particular ways that tasks are performed, such as holding a firehose, must be learned (Hartel, 2019, p.6). This early work has influenced much of the research on information practices. Examples include the research of Olsson (2016) with archaeologists where he explores the significance of touch, and Olsson and Lloyd (2016, p.1317), where in their study of car restorers they found that participants described the need “to develop a feel for the metal” they are shaping.

I understand why the focus on embodied Information Practices is important, especially in the work of Lloyd (2007, 2009), but at the same time, I also understand that in their development of Information Practices research, the work of these scholars had potentially narrowed what an Information Practices approach might bring to research. Aware of the risk of introducing a potential narrowing focus of an Information Practices approach to research in my own study, I sought to engage with a broader theoretical approach, avoiding the localised focus which dominates Information Practices research. This took me back to Schatzki's *Site of the Social* (2002), and to the work of Latour and Woolgar (1986) and led me to challenge the assumption in Practice Theory, which in many cases is also implicitly inherent in Information Practices, of the necessity of understanding the social space as a localised unidimensional space. This position is clearly at odds with the ELIS approach proposed by Savolainen (1995, 2008), McKenzie (2003) and Savolainen and Thomson (2022), or even with an approach that also engages with similar frameworks, such as Pilerot (2014a), where multiple social planes co-exist. Such a challenge is a significant attempt to advance the theoretical position of Information Practices.

To meet the challenge presented by the limiting localised level of observation, a different approach to the analysis of the social interactions underpinning information practices was called for. Almost serendipitously, I was introduced to

the idea of the Cosmic Zoom approach (McKenzie, 2022). Although this initial introduction was to a simple, practical way of linking different levels of magnification (Verrall 1968), it enabled me to re-conceptualise these multiple social planes. The idea of magnification created a practical and metaphorical link with the scientific practices of the scientists. Horton's concept of scales (2021), from his book *The Cosmic Zoom: Scale, Knowledge, and Mediation*, explored at greater depth in the Literature Review chapter, provided a theoretical-basis for an analytical tool that ultimately allowed me to propose to that the social spaces can also be understood as an interconnected series of sites, and to identify a new concept that I have referred to as Domains of Interactions, working at different levels and affecting the participants and their interactions.

Finally, the present study is significant because of its acknowledgement of the multiple roles of the researcher in the ethnographic approach used in this Information Practices study and the need to consider the implications of a researcher that is both an observer and a participant in the social context, even if only for a period of time. In doing so, the present research reflects not only on the role of the researcher, but on the writing of ethnographic accounts, which bring Marvellous Realism (cf Taussig, 1992; Juschka, 2003; Camayd-Freixas, 2014) as a mechanism to both elucidate other sites that are traditionally hidden from the normal scientific method and research, but also to facilitate the acknowledgement of ELIS and its involvement in the information practices of the scientists in this study.

Structure of the Thesis

I take a conventional approach to the structure of this doctoral thesis, presenting six chapters, Introduction, Literature Review, Methodology, Findings, Discussion and Conclusion. This overview takes the reader chapter by chapter through these main aspects of this study.

In the present chapter, the Introduction, I set out the research question. I explore the background and how the interest in the topic evolved from my studies and professional career. This chapter goes onto explore the significance of the present study, its contributions and how this study addresses a gap in the literature on scientists' information practices.

The second chapter, the Literature Review, examines the literature and concepts that are foundational to this study. I begin with the literature of Information Practices, where I provide some of the historical context and explain why this study uses Information Practices as a perspective, rather than taking an Information Behaviour approach. The section also reviews the literature on ELIS (Everyday Life Information Seeking), as well as the literature on embodiment and affect, which are crucial for the present study. It concludes with an overview of studies of the information use and knowledge creation of scientists. The following section examines the Practice Theory literature, one of the conceptual frameworks utilised in this study, where foundational concepts such as embodiment, affect and the ontology of site are analysed from a Schatzkian (2002) and Latourian (2005) perspective. I review Horton's (2021) concept of the Cosmic Zoom, which is the basis for the analytical tool of the Cosmic Zoom. The final section of this chapter explores the main works on scientific laboratories and the practices of scientists from the field of Science and Technology Studies (STS). It includes Latour and Woolgar (1986) investigation of Laboratory Life, Knorr-Cetina's (1999) *Epistemic Cultures* work and Pickering's (1984 and 1995) work on the *construction of theory of Quarks* and the *Mangle of Practice*. In addition, this section presents the work of some of the scholars in Information Science who have engaged with ideas relevant to STS and Information Practices in the context of this study. Finally, the chapter presents a review of the contribution of the 17th century Dutch man of science, Antonie van Leeuwenhoek, to microscopy and the practice of observation; his approach to scientific work influenced the group of scientists who took part in this study.

The third chapter, Methodology, explores the selection of the methodological approach and its implementation. It begins with the research question and having justified the choice of ethnography as the methodology for the study, the chapter details how ethnography was implemented and developed and how I, as a researcher, understood the dual position I assumed in the laboratory. The chapter then focuses on how data was collected and then describes the approaches to data analysis. The following section discusses the Cosmic Zoom as the analytical tool developed in this study and its implications when analysing the data collected, especially in the interviews and the observations. The next section discusses how the approach to ethnographic writing was developed, following Van Maanen's (2011) realist and confessional tales. The final section discusses how the quality of the study was ensured.

Chapter four details the study findings. The chapter describes the context, the actors, both humans and non-humans, and the physical laboratory and presents a summary of the information practices of the scientists who participated in the study. The next two sections use vignettes to situate in their social context the information practices of the scientists, their interactions with the technology and with the bacteria, their focus of their research. The chapter includes discussion of the dual position the ethnographer assumed, the use of a dual voice and reflective tone, and the use of vignettes as a literary style to describe the findings of the study.

Chapter five, the discussion chapter analyses the findings and their implications. It discusses the main contributions to of this study to research in Information Practices. These include showing how this group of scientists have developed an epistemic culture. The first section discusses the scientists' information practices and delves specifically on embodiment and affect as important aspects of their information practices, this section also examines the information practices found through this study and contrast them with empirical studies in information science. The next section focuses on the innovative approaches developed in this study, emphasising the importance of the Cosmic Zoom as an analytical tool, and the subsequent emergence of Domains of

Interaction as a conceptual innovation. The last section of the discussion focuses on the approach to reflexive ethnography adopted in this study, including the use of the literary style of Marvellous Realism to guide the writing of the vignettes.

The final and sixth chapter is the conclusion. This chapter summarises the study and its contributions, and sets out the implications for further research, in both methodology and the Information Practices research and for professional practice. It concludes with an overview of the limitations of the study.

In summary, this thesis is the report of a scholarly research project about the information practices of laboratory-based scientists investigating bacteria. It reviews the important literature, implements ethnography as an appropriate methodology for the collection of data and uses a hybrid conceptual framework to analyse the data and to inform the themes and patterns observed in the data. It presents the findings as a series of vignettes, and in the discussion brings them back in comparison with the literature that was key to this study to elucidate contribution to knowledge made by the study, concluding with a discussion of implications for professional practice and some suggestions for further research.

Conclusion

Through this chapter the reader is introduced to the journey of a professional in Information Management developing a study to research the information practices of scientists investigating bacteria in a university laboratory. The tone of the introduction is personal, as I demonstrate how I came to be engaged with Information Practices as the most effective perspective to understanding how information and knowledge is ultimately used, produced and shared and how other conceptual frameworks from sociology, such as Practice Theory and ANT were used to understand the observations and interpret the data collected.

I presented the significance of a study of the information practices of scientists working in a laboratory for research in Information Practices, indicating the

importance of a methodological and conceptual approach that challenges the commonly found localised conception of information practices, and views them as the result of multidimensional relationships across a variety of sites.

In the next chapter I will explore the literature which has informed my thinking and laid the foundation for the conceptual and empirical frameworks for the present investigation.

CHAPTER 2: LITERATURE REVIEW

Introduction

In this chapter I present the literature that underpins the different aspects of this investigation, concerned with the ways in which scientists create, share and use information, in order to answer the research questions “**what are the information practices of a group of scientists working in a university laboratory?**” I begin focusing on the literature in Information Practices. Here, I explain the choice of this literature over the literature of Information Behaviour and introduce key researchers who developed the literature of Information practices, including Savolainen (1995, 2008), McKenzie (2003), and Lloyd (2007, 2009, 2010). I note that the growing influence of Information Practices has brought about a potential situation where the terms Information Behaviour and Information Practices are conflated; some studies may use labels interchangeably without reflection on the theoretical and ontological assumptions that underpin them (Pilerot & Ekström, 2025, p.461; Huvila & Gorichanaz, 2025, p.219). I review some of the empirical studies that have examined how scientists or people in related roles use information and create new knowledge. I emphasise the importance of the social nature of Information Practices and discuss the inclusion of embodiment and affect in this research.

An analysis of this literature leads me to conclude that, in spite of conceptual developments, this literature is largely localised, focussed on the moment of observation, and therefore is mostly concerned with descriptions of what has been observed. This analysis of the literature has also led me to pinpoint the scarcity of studies focused on laboratory-based scientists, in both Information Behaviour and Information Practices.

Then, I turn to the literature of Practice Theory, which offers a more abstract way of considering practices, to examine what people do, how they talk about what they do and the relationships in which they are involved in. The practice

theoretical approach, as elaborated by Schatzki (2002), provides a holistic way of framing practices. Its emphasis on the group or social nature of practices is important, as is its concern with the involvement of the whole person. Of particular significance for this study is Schatzki's focus on the context or site of practices, an important tenet of this investigation.

It would be misleading to conclude with the work of Schatzki. It too has its gaps or weaknesses for this study. In particular, Schatzki's work is concerned principally with relationships among and between humans. The work of Latour, and in particular Latour and Woolgar (1986), is relevant here. Latour, who also has similarities with the practice theoretical approach, introduces the participation of non-human actors in social contexts. His work is particularly important for this study. His seminal work, entitled *Laboratory Life* (1986), documents his observations in a scientific laboratory and helps to shape Actor-Network Theory as a social perspective, acknowledging non-human actors as agents in information and social processes, an idea rarely found in Information Science, (see for exceptions Pilerot (2014a) and Haider and Kjellberg (2016) among others). For this reason, ANT (Actor-Network-Theory) is also used to provide an understanding of the information practices of scientists as they interact with non-humans.

It is important to discuss studies of scientists at work in a laboratory. I do this mainly through the literature of Science and Technology Studies, with a focus on those ethnographic studies that investigated the information practices of scientists. This leads me to a consideration of studies carried out by Latour and Woolgar (1986), Knorr-Cetina (1999), Pickering (1984; 1995) and I also include some authors in information science whose ideas have links and origins in STS, such as Haider and Kjellberg (2016).

Finally, I conclude with a summary of the conceptual aspects that are significant for my study, introducing the case of Antonie van Leeuwenhoek, which is important for the scientists in this study, as the father of the microscope, and which, also offers opportunities to learn about observation and contextual

practices. Finally, I reiterate the research question that will be the focus of my investigation.

Information Practices

Information Practices has traditionally incorporated perspectives from a number of multidisciplinary fields including sociology, philosophy and cultural studies (Talja et al., 2005; Pilerot et al., 2017; Savolainen, 2007). From its inception in the late 1990s and early 2000s, authors such as Savolainen (1995), McKenzie (2003), Talja et al. (2005), Lloyd (2006) and Olsson (2007), among others, have cherry-picked from influential authors in other fields, such as Schatzki, Bourdieu, Giddens, Foucault, Nicolini and Gherardi, for the conceptual frameworks of their Information Practices research.

The Information Practices approach brings a social outlook to the analysis of how information and knowledge is used, shared and created, specifically, as a social phenomenon, as other authors indicated (Savolainen, 1995; Tuominen & Savolainen, 1997; Talja et al., 2005; McKenzie, 2003; Savolainen, 2007; Palmer & Cragin, 2008; Lloyd, 2010; Pilerot & Ekström, 2025; Huvila & Gorichanaz, 2025). In this study, Information Practices is preferred over other approaches like Information Behaviour (IB), which focuses on the individual's needs and what is required to fulfill them (Belkin et al., 1982; Buckland, 1991; Wilson, 2000), because it accounts for observable factors that contribute to how groups of people carry out activities that are instrumental in the creation of knowledge.

The criticism that behaviours associated with the Information Behaviour paradigm did not provide insights into the ways these behaviours arose eventually led some scholars (Savolainen, 1995; McKenzie, 2003; Van House, 2004; Savolainen, 2007; Palmer & Cragin, 2008; Lloyd, 2010) to propose that it would be better to situate information behaviours in social interactions, and their situational contexts as the loci of research into how people use information and create new knowledge. Researchers of Information Practices can observe and investigate social interactions and draw conclusions based on the dynamics of

the social nature of information, rather than individual's needs and use of information (Savolainen, 1995; McKenzie, 2003; Talja et al., 2005; Lloyd, 2010).

Critics such as McKenzie and Talja (Savolainen, 2007) began to question the dominant view in Information Science based on Information Behaviour and its cognitive viewpoint label, that even today still dominates, at least in numbers, the landscape of information science research (Huvila & Gorichanaz, 2025). One of the main points of criticism has been the use in the Information Behaviour approach of behavioural cues to attempt to identify individualistic mental states leading to acquisition of information and information creation processes (Van House, 2004, p.58; Talja et al., 2005, p.81; Savolainen, 2007, p.114). Pilerot, (2012, 2014a, 2014b), in particular, urged a reconsideration of information sharing as a social practice, which is also a concern of Haider and Sundin (2022, p.11). In addition, scholars began to question Information Behaviour's tendency to focus on work and academic contexts (Huvila & Gorichanaz, 2025) and examination of context in Information Behaviour; a notable exception could be seen in Cox and Fulton's (2022) study of leisure activities. Therefore, these authors began to expand on their interests in everyday life information practices as well (Savolainen, 1995; McKenzie, 2003). They also saw the need to go beyond information seeking, with its focus on the use of library services and institutionalised documentary sources of information, such as the use of journals (Palmer et al., 2009). In fact, more recently authors such as Pilerot (2014a) have reflected on this dichotomy (Pilerot, 2014a, p.22).

Thus, Information Practices within Information Science indicates a departure from a traditional understanding of knowledge as solely the product of cognitive or behavioural processes (Van House, 2004, p.71; Talja et al., 2005, p.81; Savolainen 2007, p.122). In contrast, Information Practices go beyond the cognitive or propositional capacity of human beings, and the field asserts that individuals do construct information socially, beyond the limits of their own, individual cognitive ability. Further, authors such as Palmer and Cragin (2008), Pilerot (2014b), Haider and Kjellberg (2016) and Haider and Sundin (2022) have suggested the importance of acknowledging that non-human actors are involved

in information practices.

In this chapter, I begin by reviewing the context of Information Practices literature in general. Here I provide a rationale for using Information Practices ideas rather than Information Behaviour. Then I review in particular the context and literature for three important aspects within Information Practices of relevance for this investigation, everyday life information seeking, embodiment and affect. Finally, I review the literature in information science that has a focus on the information activities of scientists.

Context in Information Practices

The Information Practices perspective has enabled researchers to take an analytical approach to what is referred to as context in the Information Behaviour literature. For Information Behaviour, the specific situation, tasks or interactions, triggers an information need (Savolainen, 2012, p.6-7), a gap or anomaly in the understanding that needs to be solved (Belkin et al., 1982; Dervin, 1992), and is concerned with the subsequent information seeking behaviour to fulfill such need. Such an approach could be helpful to determine the particular information needs of an individual at a point in time and the steps to fulfill such needs. It assumes a linear and systematic process, in that the information needs are a direct result of the needs, and the behaviour to seek information is a response to the need triggered by particular circumstances. However, it has no deep concern for those circumstances, as argued by Lloyd (2006, p.572), to understand how people engage with information. It is important to be able to identify collective understandings, rules and associations that shape the social environment itself. Information Practices provides an approach which facilitates this understanding.

Savolainen's model of information seeking within everyday life (1995), with its emphasis on "way of life" contributed to the discussion of how to understand context, by drawing on Bourdieu's concept of habitus, where context is created through upbringing and social convention (Savolainen, 1995). McKenzie (2003) proposes a model of Information Practices for everyday-life seeking, in which

the “individual-in-context” is an alternative to the procedural and structural information seeking process sometimes proposed by Information Behaviour; she also acknowledges the information practices of non-systematic everyday life processes that can be serendipitous and idiosyncratic. This way of understanding information processes is important for this investigation because it allows for incidental, dynamic and ad-hoc processes that in many cases cannot be explained by systematic information seeking behaviour.

Both Savolainen (1995) and McKenzie (2003) identify context as an important parameter for information seeking and use. However, they proposed other less structured contexts, beyond environments such as work and academia, in which individuals seek to orient and order their life based on how they interact with situational aspects in their environment. This is important because the way individuals interact with information is in great measure related to their situational and contextual reality (Savolainen & Thomson, 2022, p.525). On the other hand, other scholars such as Pilerot (2014a), Lloyd (2006), Gherardi (2008, p.517) and Knorr-Cetina (1999), provide an understanding of knowledge creation as situated and performative, and the importance of social context and material objects as elements that could constrain and enable practices beyond individual needs and mental states.

This conceptual focus is on context being created through social, implicit rules (Lloyd, 2010, p.249; Olsson 2007, p.222; Mansourian, 2022; Zhang et al., 2024). Other studies show how social contexts are important for how embodied practices are performed (Lloyd & Olsson, 2019, p.1314). For example Lloyd and Olsson (2019) show that embodiment practice is critical for the use and “acquisition” of information (p.1317), and that the body is critical to interacting locally in space as knowing can be embodied and a source of information (Lloyd & Olsson, 2019, p.4). Lloyd has also investigated the body as a site of information practices (2014, p.4), to highlight the existence of non-symbolic information processed by the body and other non-cognitive ways to learning and understanding the world.

In general, the view of context in information practice is critical for this investigation. Understanding the ontology of site factors that constitute the context, allows this investigation to contrast the physical boundaries of the laboratory, with other domains in which participants interact, making it possible to trace sayings and doings as aspects of their practices, that transcend the location where their investigations take place.

Information Practices in Everyday Life

The Everyday Life Information Seeking (ELIS) approach is beneficial for this investigation to examine the information practices of scientists beyond the work-related environments. It allows a consideration of how other aspects of their lives, like parenthood or immigration status, affect their information practices. In his seminal work, Savolainen (1995) stresses the importance of analysing how individuals use, seek and share information in other areas of life beyond the professional and academic spheres. For example, his concept the “way of life” operationalises quotidian aspects of life, such as time management, hobbies and daily tasks such as consuming goods and services (p.263). In this regard, Savolainen (1995) echoes Dervin’s approach (1992) which offers “sense making” as a framework for problem solving by seeking information in daily life hurdles. Savolainen (1995, p.259), however, proposed a framework with two components, the “way of life” and “mastery of life”, to understand the information practices of everyday life.

In developing these ideas, Savolainen used Bourdieu’s practice theoretical approach. He attempted to use the thinking tool of “habitus” to demonstrate that information seeking is a normal aspect of everyday life. He found value in this concept, taken as the socially influenced dispositions by which individuals orient their life. This was crucial for Savolainen’s initial approach (Savolainen, 1995, p.262), because such inclinations or habits are ways in which the social context and interaction shape certain choices during the course of life. He theorised that the same happens for the information practices of everyday life. Thus, for Savolainen, at that time, socially determined structures influence the individual’s

“way and mastery of life”, that is, the ways in which individuals organise their own information practices, influenced by the social contexts in which they live. Savolainen subsequently found he was unable to identify robust ways to determine the characteristics of his concepts of “way of life” and “mastery of life” and moved away from his original approach using Bourdieu, to a more “flexible model” influenced by Schatzki (Savolainen & Thomson, 2022, p.516).

Savolainen (2007, p.111) identifies McKenzie as one of the early advocates of Information Practices. In her concern with the everyday information practices of ordinary people, and the ways they demonstrate expertise, one can see a reflection of Savolainen’s ideas of “way of life” and “mastery of life”. One of McKenzie’s main concerns is that more “holistic” approaches were required to incorporate the actual information practices of individuals through their everyday lives (McKenzie, 2003, p.19). In an early but influential study, McKenzie (2003, p.19) proposed a model of information practices that looked to the social and situational interactions of individuals and the communicative process by which they acquire information, within the context of their daily lives. In this model, Everyday Life Information Seeking (ELIS), she noted that there are in fact, instances of “active seeking” and “active scanning”, behaviours central to Information Behaviour (McKenzie, 2003, p.26), but that in addition, there might be “less direct”, and even serendipitous ways, in which people also discover information via in their everyday interactions, without necessarily actively seeking or meaning to scan for particular information. She concluded that attaining information in less rigorous and more incidental ways was important for the ways people constructed their worldviews.

In her study of pregnant women expecting twins, for example, McKenzie (2001) explored the different avenues or practices individuals adopt to seek information, and the different ways in which they acquire it. Based on her findings, McKenzie (2003) was able to conclude that in these non-work, non-academic situations, people exercise a number of practices relevant to their social group, not traditionally found in Information Behaviour research, which tends to focus on active information seeking (cf McKenzie, 2003, p.19), that

help them to solve problems in their daily lives. Thus, both Savolainen (1995, p.272) and McKenzie (2003, p.26) were able to demonstrate, from within their conceptual perspectives of ELIS and the “way of life”, that in people’s everyday lives, information could come to them actively and passively, and even unintentionally or serendipitously.

McKenzie and her ELIS approach encouraged other scholars to start using social perspectives to information research, and to move the focus of research away from the work or academic setting (McKenzie, 2003, p.19; Savolainen, 2007, p.121). In so doing, she broadened the conceptual understanding of how people use information in their everyday lives in a less active manner. Pilerot (2014a, pp.22-23) does not specifically comment on ELIS as a discipline. However, he acknowledges that it may be difficult to separate a person's work and non-work environments, as the boundaries between different aspects become blurred, making the identification of segregated information practices challenging.

Embodiment in Information Practices

This section focuses on the importance of embodiment and the relevance for this study. Lloyd was also influential in the adoption of an information practices approach. In her work (e.g., Lloyd, 2010, p. 248) we can see the influence of Savolainen (1995) and his use of “habitus”. We also see the influence of Schatzki’s site ontology (2002). The site for Lloyd, based on Schatzki’s understanding of the social context, is the context where social practices emerge in relation with those material objects that make up part of the environment. Thus, in acting and performing through social practices, individuals not only enact the “knowing what”, but also the “knowing how”, responding to their environment, not only intellectually, but also, bodily and affectively (Lloyd 2010, p.249). This performative aspect of practice is also amplified by authors such as Pickering (1995) and Gullbekk (2021).

It is this emphasis on embodiment that has made Lloyd particularly influential and widely cited, which stands in contrast with traditional cognitive

understandings of information (Talja et al., 2005, p.81). Lloyd (2010, p.247) proposes the body as participant and central to information practices. She argues that information practices are embodied, in that knowledge is not only intellectually and socially constructed, but also bodily performed in many circumstances.

Lloyd's work with fire fighters (Lloyd, 2006) and ambulance officers (Lloyd, 2009) has clearly demonstrated the significance of embodied knowledge. Lloyd (2006, p.570) extends the view of Information Practices research through her work by contemplating how embodied experience and social connection provides other ways of knowing (Lloyd, 2006, p.570). She questions the tendency in Information Behaviour to focus on a cognitive or skills-based view. Lloyd proposes in her studies (2006, 2009) that the knowledge of firefighters and ambulance officers is, in large part, performative and embodied, arguing that members of these communities of practice are "knowledge workers", even if they are not part of an academic community and that their knowledge is not only text-based, but based on social relationships and physical interactions.

Lloyd's work has given a platform to other authors (Olsson, 2024) to delve into the implications and importance of embodiment, not only as a contributing factor, but also as a source of information and the result of social and cultural shared practices. For example, Williams et al. (2024) have investigated the importance of embodiment for communities of ultrarunners. In their study of the ultrarunning community, they found that social media provides visual affordances to create, use and share embodied information with the community. For car-restorers (Lloyd & Olsson, 2019), the demonstration of how to hold and manipulate a particular tool, for example, is an important mechanism for knowledge continuity and propagation among the members of the network. Interesting, as well, is Olsson's work on the information practices of archaeologists interacting with archaeological sites and objects. In this study, he shows how archaeological findings are often interpreted and understood by bodily experiences of the object (Olsson, 2016, p.4). He highlights the importance of the sense of touch in the "haptic" understanding, in other words

the sensorial or tactile way of knowing, something that goes beyond any intellectual understanding, shedding light on the importance of the physical interaction with objects for members of this occupational group.

Lloyd and Olsson in their treatment of embodiment, have shown how it is critical in obtaining a full picture of the information practices constituted in a social context. This is of relevance for this study, because of scientists' physical involvement during experiments and observation (Latour & Woolgar, 1986; Knorr-Cetina, 1999). Therefore, the importance of embodiment and information practices can hardly be overstated for this investigation.

Affect in Information Practices

Another important aspect of information practices is the consideration of affect and its relationship to the ways people produce knowledge. Somewhat overlooked in the past (Savolainen, 2014; Gherardi, 2017; Hartel, 2019; Huttunen, 2025), affect has begun to be considered by scholars as critical for individuals to make sense of the world and to enable them to keep up with circumstances as they bridge gaps on their information; this was a point made by Dervin, thirty years ago (see Dervin, 1992). For authors such as Lloyd and Olsson and more recently Leith (2019, 2018), along with the significance of embodiment in information practices is the importance of affect as a factor related to the individual's physical interaction and response to her context, or as Nahl indicates a mechanism to cope with the circumstances (Nahl, 2007, p.3). Gherardi (2017, p.345), for instance, indicates that the turn to affect in practice is intimately linked to embodiment and the interaction with a social context that may also include non-human actors (Huttunen, 2025).

A number of authors researching in Information Practices have also paid attention to affect, as an important facet of information practices. For example, Savolainen (1995), as part of his model for everyday life information seeking, contemplates affect in combination with cognition as a part of a "sense-making" process to solve gaps in the individual's information. The model takes into account the emotional factors that could affect an individual, in addition to

cognitive-analytical factors that may influence the orientation or motivation of a person during the problem-solving phase (Savolainen, 2014). In a later paper, written with Thomson, Savolainen (Savolainen & Thomson, 2022) reiterates the importance of affective factors in information practices, as they expand on his original model, indicating that a person may accentuate cognitive or affective aspects while solving a problem by taking different attitudes to seeking and using information.

Olsson (2016) findings, on the importance of affect in the enactment of information sharing practices of archaeologists, highlighted a different aspect of affect, that affect, and humour (see also Leith, 2019) can lead to an inviting social environment that facilitates the sharing of experiential knowledge during an archaeological dig. The acceptance of affect as a component of information processes is certainly for the most part a recent development within information science that has been a consequence of the influence of Practice Theory and the social discourse in Information Practices (Schatzki, 2002; Nahl, 2007; Gherardi, 2017). Research in the field is beginning to identify that humans construct information affectively as they react to their environment, their social context and their circumstances. Thus, it is important to identify it as a factor that may be influential for scientists as they create, use and share information.

Scientists and their Use of Information

There is a tradition in Information Science of researching the information needs and uses of scientists and scholars, going back more than 50 years.

Nevertheless, the number of papers taking an Information Practices perspective is small, however, they are currently growing in number and influence (Jones, 2005, p.88; Palmer & Cragin, 2008; Huvila & Gorichanaz, 2025).

Chen's paper on the information needs of scientists, published in 1974 was one of the earliest studies to focus on scientists, their needs and the uses they made of information, rather than on the use of the services of a library. The scientists in her study were physicists employed in one of six universities. In order of importance to them, they ranked formal publications, followed by semi-

formal publications, reference materials, meetings and conferences, and finally informal oral communications. More than half scanned up to three journals a week. The library was important for these scientists in keeping up to date as it was the source of the journals that published key findings.

Hemminger's papers are an important referent in the change in focus of studies of information use, as they remind the reader of the importance of context, in this case the use of ICTs in the consideration of information practices. The British Research Information Network has undertaken three studies of the information practices of scientists and scholars. Most relevant to this study is *Patterns of information use and exchange: case studies of researchers in the life sciences* (2009). This study includes case studies of researchers in various fields of life science, although there is no case study of micro-biologists. Nonetheless, given the relatively small number of studies of laboratory-based scientists, the findings are of relevance. This study was undertaken at a time when scientists were still coming to terms with the new information technologies (2009, p. 4), but at a general level, the key findings remain relevant in 2025. The study found significant differences in the ways information was used and shared across the different case studies. Researchers may be part of other projects and even other research teams, with more experienced researchers being engaged in collaborations (p. 5). Organising information and data is a key activity, with most scientists taking an informal idiosyncratic approach to the process, as no one has been given the responsibility of managing the use of the new tools and technologies and the data they generate, nor to train other research group members in how to organise and store their data in a usable form (p. 34). The scientists' main goal is to extend society's understanding of the natural world and to communicate their findings (p. 7). While this requires collecting and interpreting data and information, this part of the scientific process is not a goal in itself. The world of science and of research rewards publication of findings in formal sources but gives less value to communication using other media (p. 38). Finally, the study found that the concern at the time with sharing research data overshadowed the formal and informal data sharing

that marked ongoing collaborative relationships (p. 38), both within the research group and with others.

Hemminger et al. (2007, p.2205) drew attention to the influence of computer technologies on the ways scientists use information as more electronic resources became available, having an impact on the use of services provided by libraries. In a study whose goal was to identify resources used in the research process, their survey analysed responses from nine hundred and two participants, from various science departments in the University of North Carolina, and found that in comparison with research conducted a few years earlier (Jirojwong & Wallin, 2002, p.70), 49% of respondents were inclined to use journals as the main source of information. Hemminger et al. (2007, p.2208) found that other electronic methods, such as web pages (70%), online databases (67%) and personal communications (52%) were becoming prevalent as access to the internet increased and offered greater convenience. In addition, the study also notes the decrease in the preference for physical library services, with library collections (1%), coming last on the list of preferred resources. The research found an emphasis on convenience and cost, with access to electronic resources and Open Access journals emerging as an increasing trend (p.2211). Finally, the authors indicated some nuances between disciplines and an increase of electronic resources as trusted and convenient sources when compared to library services.

Other studies investigating different clusters of scientists, scholars or students, have also identified a change in behaviours with the emergence of electronic resources. Haines et al. (2010), for example, investigating the information seeking behaviours of science researchers, found that researchers used a number of electronic resources such as search engines and online databases, as well as interaction with colleagues to keep current with latest knowledge or source material. The study shows a variety of strategies and sources for searching for information, including some discipline focused databases and Google, and when questioned about library services, the study reported less knowledge about the different services the library could offer, including access

to the library's databases (p.75-76). This finding is in agreement with Hemminger et al.'s findings (2007), which demonstrated an increased preference for electronic resources over library services. However, Gordon et al. (2022) analysed the information seeking behaviours, attitudes and choices of one hundred eighty two academic physicists, with different positions and highlights that only 15.4% of academics felt they were successful in keeping up to date, indicating a sentiment of not being able to understand if one has exhausted all new advances in the field (p.299, 303), due to the scope of available information and the time required to keep up to date. These numbers varied according to position, with differences existing between graduate students and experienced researchers. When it came to resources used, digital resources such as arXiv and Google Scholar were identified by 71.4% of respondents as being used frequently, and personal communication was also indicated as a frequent resource. The study also reported a difference in seeking behaviours, between graduate students and experienced researchers, similar to the findings of Research Information Network (2009).

The study by Sahu and Singh (2013) of the Information Seeking Behaviours of Indian scientists in astronomy and astrophysics fields, also showed differences in the specialised needs for different subcategories of astronomy and astrophysics, although working on a project was the main reason for 94.4% of respondents, for searching and using information (p.122). As in other studies (e.g. Gordon et al., 2022), they found a difference between older and more established scientists who preferred personal communication to remain up to date, while the younger generation and students were more aware of electronic and printed resources. The participants in the research highlighted that their preferred methods were face-to-face interpersonal communication (84.3%), e-journals and databases and literature searching. Conferences and meetings were reported as the most important source of information by the majority of respondents. Only 43.4% indicated that discussions with library staff was an avenue to identify relevant information (p.123). Another distinction Sahu and Singh (2013, p.117) pointed out, was the increasing reliance on electronic and online resources for the younger generation, when compared to the older

generation, who relied more on their own personal collections. The report shows that 45.51% of respondents access online databases daily, against a 28.5% accessing resources weekly.

Niu and Hemminger (2012, p.336) found that academic positions and experience were the greatest factor affecting the academic researcher's behaviour when seeking information, which is congruent with findings from Sahu and Singh (2013) and Gordon et al. (2022). Their large study analysed survey's responses from 2,063 researchers across various fields and universities and found that scholars invest on average eleven hours per week reading. Respondents indicated that journals, web pages, and personal communications were daily strategies for seeking information (p.341), in addition to other sources of information, such as books, preprints, etc. The report also indicated, in agreement with other research, that electronic sources were preferred as sources of information (p.342). The study compared the information behaviours of male and female scholars and found that male researchers downloaded more electronic papers than female respondents and that senior professors retrieved more information than junior academics, in terms of searching and reading preferences, 96.3% stated a preference for searching online, in part due to convenience, which is a similar finding from Hemminger et al. (2007). However, the majority of respondents indicated that they preferred to read a combination of electronic and print format, with the actual format depending on the depth of reading needed. Print formats were preferred for in depth reading, highlighting or annotating (p.344). The report indicated that the majority of literature searches were done online, either via search engines or library websites (p.345). Similar to findings in other studies (cf Sahu & Singh, 2013; Devi & Lawanda, 2023), use of library services, including visits, had been decreasing, with an average of 25 visits in a year.

Devi and Lawanda (2023) surveyed three hundred thirty five scientists in Indonesia, to understand aspects that affect scientists Information Seeking Behaviour. The research found among other things and in correspondence with Niu and Hemminger's (2012) findings, that the academic role was the biggest

factor in information seeking behaviour for scientists in Indonesia. The study also showed that 91.1% of researchers chose open access sources and the use of search engines, with 78.8% of participants preferring Google search services to find information and affecting their expectations of the library web site experience. In regard to visits to the library in the prior twelve months, respondents of this study indicated five to six visits annually, a decrease when compared with an already decreasing pattern noted by Niu and Hemminger (2012). Meanwhile, Kwon's study (2017) focused on scientists in laboratories during their research lifecycle. The report highlighted that socio-cultural norms and position affect the Information Seeking Behaviour of participants. The author used Activity Theory as a framework to analyse the data and found with a sample of twenty four participants that there is a marked division of labour between the principal investigator and junior scientists (p.12-13); the research indicates that each position exercises different roles through the research lifecycle. This study drew on the work of Latour and Woolgar (1986), taking account of objects and tools used as part of the Information Seeking Behaviour, although not to highlight the agency of these non-human actors.

In a similar vein, Ellis and Haugan (1997) investigated research scientists and engineers in an oil and gas company, to identify the patterns and strategies of information use by each set of professionals. Ellis and Haugan used grounded theory as a framework and found six information seeking patterns, namely, surveying, chaining, monitoring, browsing, distinguishing, filtering, extracting, and ending. The study focused on the information seeking behaviour of these professionals in the context of the projects' information requirements. The study identified three different types of project, each with its preferred preferences for gathering and sharing information. Face to face sharing of information in short and technically viable projects was preferable over electronic communication; the report also indicated a preference of choices for sourcing information, with personal contacts first, personal knowledge and experience second and finally the library in third place. In the case of radical projects (Research and Development projects with medium chance of success), internal company communication was preferred for commercial reasons; the hierarchy of

preferences for this type of project was, first personal knowledge and experience, second personal contacts and third the library. Sharing information was done orally, through meetings or electronically within the organisation, while searching was done through online databases. In the case of fundamental projects, which were considered as high risk, the hierarchy of preferences was library first and personal knowledge and experience second. The report also noted the electronic search of literature was important, sharing information was done through project meetings, face to face and delivery of information between project members (p.394) and searching was done by monitoring online databases.

I turn now to examine some of the smaller number of studies on the information practices of scientists. Palmer and Cragin (2008) reviewed literature on *Scholarship and Disciplinary Practices*, which focussed on scientific and scholarly communities. Palmer and Cragin acknowledge the increasing impact of the social viewpoint of Information practices and encourage Information Science researchers that in addition to focusing on individual information needs, they also adopt a social approach for understanding knowledge creation within scientific disciplines (Palmer & Cragin, 2008, p.166). This comparative analysis focuses on the evolution of practice-oriented studies and identified in the literature a change, indicating that scientific and scholarly communities were adopting a greater range of technologies, resources and searching practices (p.179). The authors however pointed out that the previous research focus on technology and use overlooked other potential information activities that may have been involved in the research process. Another interesting point highlighted by Palmer and Cragin, is that the literature began to identify that the use and preference for printed journal articles was starting to change and the use of digital resources and internet or online tools was increasing (p.182-183). In summary, the study highlights that the use of the term “practice” is sometimes used loosely (cf Pilerot & Ekström, 2025), without reflecting on the theoretical implications of this socio-material approach. The paper also highlights the materialist awareness of information practices and the lack of application of the socio-material view on information science (p. 170). The authors call attention to

the need to move from an individualistic perspective on systems optimisation, to look into the socio-technical dimension of scholarly groups.

In a later study, Palmer et al. (2009) investigated the discrete information activities that various scholarly groups enact for the production of scholarly knowledge, dividing them into categories of analysis, namely searching, collecting, reading, writing, collaborating and cross-cutting primitives, with the objective of designing better digital services for academics (p.3). Palmer et al. adopted a social outlook acknowledging the importance of Information Behaviour but highlighting the benefits of a social perspective that goes beyond the individual needs (p.5-6). The authors highlight the crucial role of information activities on the research and production of knowledge, and they found an increased use of online activities and highlighted the challenge for libraries to develop integrated services that could be relevant for scholars' expertise and which could be offered digitally. The authors analysed each of these information activities and their particular subtasks, such as chaining or browsing. They focused on the humanities, sciences and interdisciplinary fields and concluded that there are some differences among the fields, however there are some common subtasks, such as chaining, accessing, assessing, disseminating and networking that are common to all fields.

Thakral's study (2021), which focuses on the information practices of health professionals managing public health crisis caused by antimicrobial resistance and the role on information systems on inequality and ethics, is one of the very few studies where the content is related to the scientists taking part in this study. The study takes a social approach focusing on ecosystems of physicians, pharmacists, patients, medical representatives, family and friends and highlights how the potential influence of digital technologies can have a role in minimising inequalities, by making information centralised and more readily available to health professionals (p.9).

Another example of a study using an information practices approach is that by Roos (2015), which focuses on the information practices of medical scientists in

the research context. The study reports, as Ellis and Haugan (1997) and Kwon (2017) also found, a division of activities between principal and senior investigators with supervisory roles and PhD students as the main authors of articles, nevertheless, with the contributions of the whole team. Roos highlighted that library visits were only made when absolutely necessary and mainly done by junior scientists. The report also highlighted the different motivations for sourcing information with web tools, where junior members' main objective could be studying for exams, while for senior members it was the creation of knowledge. The report highlights the sources for research ideas coming from prior good results, clinical cases, experience, colleagues' interactions and published literature. Some of the main findings are the use of PubMed as the main tool for searching literature and the use of Google for more general and broad information search, with only one researcher using advanced techniques such as Boolean syntax for searching information (p.30). In the case of monitoring and chaining, the report found that it was not systematic, with a number of strategies employed, with PhD student using email alerts in PubMed and some senior researchers using citations to their articles, among other strategies and tools. When it came to tools and artifacts, the most important source was journal articles, but other tools such as textbooks, Wikipedia and Google were also used for background knowledge. In the case of sharing information, the participants met at what was called "journal club", where information and knowledge was shared among the participants. Roos concluded that main phases for search and use of information was done at the beginning and end of the research, the use of electronic or online tools was prevalent, and the use of journal articles was the main source of information.

Jones (2005) carried out a study of scientists in the experimental life sciences using cognitive ethnography and activity analysis to understand how they use information when collaborating in research projects, in order to identify the information practices and artifacts during the research lifecycle. While the study identifies seven information practices, namely, managing research, conducting research, generating inquiries, experimental investigation, research information seeking, research and related conversation and preparing article manuscripts,

his concern is with the contribution that these practices make to the research lifecycle. The study also makes a distinction between individual information behaviours such as scanning journal articles and collaborative tasks as a consequence of projects, such as analysing, requiring distributed cognition, tracing an evolution from individual tasks to more social activities (p.96).

A more recent studies taking an information practices approach has examined the information practices of citizen science in the context of the identification and reporting of biodiversity species (Ekström, 2024a, 2024b). Ekström adopted the concept of “inscriptions” from technological devices from Latour and Woolgar’s (1986) research, as a mechanism for translating information into material and traceable entities that could travel across multiple contexts and become epistemic objects (Ekström, 2024a, p.43). The influence from Practice Theory, rather than from information practices more narrowly defined, becomes evident, as he highlights the socio-material context in which practices arise and are constituted (Ekstrom, 2024b, p.7). Similarly, the influence of Latour and Woolgar (1986) is evident in his concern for how material objects such as mobile devices, web portals, GPS instrumentation, could have an impact on constraining or enabling the information practices of participants.

Gullbekk (2021) also engages with Practice Theory, and ANT as conceptual frameworks, although his concern is with scholars rather than with scientists. These conceptual frameworks enabled him to elicit a hybrid approach to understanding how researchers navigate multiple disciplines and literature traditions. Gullbekk found a differentiation between larger and more established practices, practices-as-enacted, as the more or less stable arrangements of material elements, understandings and meanings, the knowing what, when and how (Gullbekk, 2021, p.10) and practice-as-performed, as the product of imminent reactions to relationships between human and non-human agents, flowing and dynamic responses to an always changing reality and a materialised instances of such emerging relationships, Gullbekk (2021, p.21).

Surveying research in Information Behaviour shows that many studies add

empirical data through explorations of different groups but still lack emphasis on the information practices of scientists performing the scientific method in the laboratory (Jones, 2005, p.88). For example, Huvila and Gorichanaz (2025, p.221) in their review paper found that less than 5% of research focuses on groups such as researchers. Another important point is the lack of conceptual support, with many studies presenting empirical data but not indicating theoretical foundations (Huvila & Gorichanaz, 2025, p.219; Pilerot & Ekström, 2025). Huvila and Gorichanaz (2025, p.220) indicate that papers with Information Behaviour related concepts represent the majority of the studies published between 2016 and 2022, with only a 4.7% representing research in information practices. There are few studies that make significant conceptual advances leaving those studies that do make such advances to look outside of the field for a more robust theoretical foundation.

In the section that follows, I explore Practice Theory and reflect on the ways it can support my investigation. I adopt Schatzki's approach, and I am particularly influenced by *The Site of the Social* (2002). I review embodiment and affect from a Practice Theory perspective. In addition, I engage with the concept of site and its ontology, an important notion for this investigation and the development of the Cosmic Zoom analytical tool.

Practice Theory

Practice Theory as a social approach emerged in the 70s and 80s, with the works of Pierre Bourdieu and Anthony Giddens in the social space, and with philosophical roots found in the work of Ludwig Wittgenstein and Hubert Dreyfus, as a reaction to structuralist and individualistic theories (Schatzki et al., 2005; Spaargaren et al., 2016, p. xiii). In general, the approach views individual interactions and their activities as critical to the social environment (Lloyd, 2009, p.248). Used as a conceptual framework, it attempts to examine the persistent activities of individuals and their common understandings within societal contexts (Pilerot et al., 2017, p.5).

In the context of Information Practices, several authors have been influential in the development of a practice theoretical approach. These include Schatzki, Gherardi, Nicolini, Latour and Knorr-Cetina, who, among others, have contributed to the enrichment of the perspective and have also been influential to a certain degree in Information Practices studies (Pilerot et al., 2017, p.5; Huizing & Cavanagh, 2011, p.2).

The inception of Practice Theory and its preoccupation with understanding the social processes by which knowledge and information are constructed has opened the doors for researchers to explore how humans generate knowledge in other ways beyond their cognitive capacity (Gherardi, 2017, p.348; Savolainen, 2007, p.120; Palmer & Cragin, 2008, p.179; McKenzie, 2003, p.24). Such displacement of individual cognition from the centre of the process, has given researchers freedom to research other aspects that are also relevant for knowledge and information processes (Gherardi, 2017, p.348; Lloyd, 2009, p.248; Talja et al., 2005, p.81). Thus, the emergence of Practice Theory has brought a richness and variety in how knowledge creation is understood in Information Practices, with many facets that are particular to Practice Theory research, including the preoccupation with social aspects of knowledge construction, the acknowledgement of socio-material environments, the decentring of human and cognitive views and the interest for corporeal or non-cognitive ways of knowing (Pilerot et al., 2017, p.4; Huizing & Cavanagh, 2011, p.3).

Practice Theory has provided a foundation for researchers to analyse social environments from the perspective of social interaction and practice (Pilerot et al., 2017; Huizing & Cavanagh, 2011). Schatzki's approach is particularly relevant for this study, and it is used to establish the conceptual framing of a theory of practice for the study. In his book *The Site of the Social*, Schatzki (2002) argues for a new social ontology, one that is collective, in the sense that it is not reducible to individual action (Schatzki, 2003, p.175). He argues that the societies in which we live emerge from the systems that surround us and from our own agency in interacting with such systems. This focus on the social, on

the collective and on the engagement of more than a person's cognitive abilities is core to my interests in the work of scientists.

Practices are evident in the “sayings, doings and relatings” of people (Schatzki, 2002, p.72; Leith, 2018, p.17). That is, in the shared language that members of a social group use to talk about what they know and what they do; in the commonly accepted ways in which they carry out tasks and actions; and in the ways they inter-relate with each other and with the systems that constrain them. Practices are not to be understood as logical rational sets of actions, even though they are guided by the norms and conventions of the society, but as expressions of a combination of the cognitive, embodied and affective.

Fundamental to Schatzki's understanding of practices is that people do what makes sense to them in their world and thus they repeat actions and tasks in their interactions. These repetitive practices are part of a collective understanding of social interactions. They are constrained or enabled by social understandings and rules (Lloyd, 2009, p.248) and make up the social context as the result of interwoven relationships among individuals (Schatzki, 2003, p.174). Knowing and doing are inter-related in a continuous social process (Nicolini, 2009).

Also fundamental to Schatzki's understanding of Practice Theory is the view that the “realm of the social is entirely laid out on a single level” (Schatzki, 2016, p.28) In the same sense, Latour views the associations between actors occurring in a single plane of reality. This view of social relationships has been influential. However, while it may be the case that interactions between people occur on a single level, on the other hand, it is also the case that, in their thoughts, people move across different planes or levels (Latour, 2005, p.36,64). This idea will be explored in more depth a later section about site ontology.

Similarly, the concept of site is crucial not only for Schatzki's social ontology (Schatzki, 2002), but for Latour's (2005) ANT as well, which he refers to as the “actor-network” (Latour, 2005, p.220). A site is where actors maintain relationships and change is produced. Incidentally, it is also important to note

that Latour places emphasis on the idea of actors moving agency across sites (Latour, 2005, p.164). However, Latour puts forward a flat view of the social, by tracing associations where actors are connected through multiple sites but unpacked, according to Latour, in a single plane of action (Latour, 2005, p.165). It is possible to see how both Schatzki (2016, p.28) and Latour favour a flat ontological position about the social space, which will have implications for the consideration of the “Cosmic Zoom”, later on, as an apt analytical tool.

In the sections that follow, three important aspects of a practice theoretical approach from Schatzki’s perspective, relevant for this study, will be explored. I begin with embodiment and affect as significant aspects of my investigation. Second, I address the concept of site ontology, that is, the context or setting within which practices take place. Site is also important for other practice-based frameworks and in particular, I examine Latour’s treatment of the concept of site. Here, I draw on the work of Latour in his development of the Actor Network Theory, specifically on his concept of agency.

Embodiment in Schatzki’s Practice Theory

Schatzki’s definition of practice is illuminating. He (2002, p.11) defines practice in general as the “embodied, materially mediated arrays of human activity centrally organised around shared practical understanding”. The emphasis on “embodiment” brings to the forefront the idea that knowledge could also be performative (Pickering, 1995), in that there is a sense in which the physical and sensory apparatus are fundamental to enquiry, and in which physical experimentation (Knorr-Cetina, 1999, p.94-95) is critical to processes of knowledge construction, as scientists interact with their environment mediated through their body and senses.

With this awareness of embodiment (drawn here from studies in Information Practices and STS), I am influenced by research that contemplates the role and influence of the body and its sensory apparatus on the production of knowledge. Knorr-Cetina (1999, p.94), for example, criticises the traditional “disembodiment of sciences”, due to new technological developments that surpassed the

capacity of the body to be used as a reliable instrument of inquiry, and she reflects on the ways the body has a relevant participation in the sciences as she classifies the role of the body in science, from three perspectives that she calls: “the acting body”, how scientists interact corporally with their environment, “the sensory body”, how individuals perceive the environment acting on them, and both aspects are what she calls the “experienced body” (Knorr-Cetina, 1999), the way in which the individuals navigate their environment, not only consciously, but corporeally as well. This categorisation is important for my understanding of the topic.

Practice Theory makes the distinction between the bodily functions and the conscious mind (Knorr-Cetina, 1999, p.95), an important point of distinction between other cognitive and realist approaches, and what many authors in Information Practices have criticised about some approaches with a behavioural emphasis (Savolainen, 2007, p.117; Olsson, 2007, p.220; Talja, 2010, p.205; Pilerot et al., 2017, p.3). This sense of corporeality and embodiment recognised in Information Practices by some authors (cf Lloyd, 2009; Lloyd, 2014; Olsson & Lloyd, 2016; Cox, 2018; Cox & Fulton, 2022; Williams et al., 2024), brings into focus and helps us to acknowledge, that there are physical and sensory senses with which humans learn (Talja, 2010, p.206; Gherardi, 2017, p.346; Knorr-Cetina, 1999, p.97). These senses are fundamentally relational and depend primarily on the interaction of the observer with his or her environment and with others, going beyond the mere intellectual realm. In other words, there is the recognition that there are ways in which individuals make sense of their reality beyond the cognitive realm. As humans, we use our body both to interact with the environment and to be affected by it (Knorr-Cetina, 1999, p.94, Nahl, 2007, p.3), and that body ultimately also works as a source and site of information and knowledge (Lloyd, 2014).

This gives knowledge construction a layer that goes beyond signs and semiotic symbols or a propositional character (Gherardi, 2017, p.348; Lloyd, 2014, p.2), to include the body in its acting, sensory and experiential capacity (Knorr-Cetina, 1999, p.95) and provides an affirmation also that the socio-material

arrangements where practice emerges are an integral element of how individuals and groups build knowledge. Thus, it also contributes in this study to build a more robust understanding of information practices in a scientific laboratory (Olsson, 2010, p.272).

Embodiment is an important aspect of scientific practice and of the scientists' experience. The Practice Theory understanding of local interactions within the local context offers a robust framework under which to understand the observation of scientists at the bench and during microscope observations.

Affect in Schatzki's Practice Theory

In his theorisation of practices, Schatzki (2002, p.59-60) explains that practices are the actions that occur within shared "understandings" of human agents and, in considering how these shared understandings are reached, he highlights that human-agents have certain dispositions directed by what he calls the "teleo-affective" structures (Lloyd, 2009, p.246; Leith, 2019, p.503). What the idea of the teleo-affective structure seems to recognise is the complex and ever-changing set of variables around human-agents, and how, operationally, emotive aspects could work as a calibrating effect to cope with and accommodate to gaps in information (Dervin et al., 1992), or the multitude of triggers and demands from the environment and other actors. As reality presents itself to the observer, social norms in the shape of emotional responses can work as mechanisms for individuals to dynamically accommodate to new circumstances and influences exerted on them (Gherardi, 2019; Savolainen, 2014).

In this regard, Schatzki (2002, p. 61), states the following: "Practical intelligibility [a key element of practices] is teleologically and affectively determined". What Schatzki (2002) seems to be trying to convey here, is that practices are constituted as the results of particular goals that enable action and how those goals and actions matter to the individual (Schatzki, 2002, p. 3; Lloyd, 2009, p.249). From this perspective it seems as if affective responses are only determined by the context. I am attracted to the approach taken by Gherardi

(2017, p.348), for whom affect is not only constrained to context, but also encompasses a number of potentials, a way to respond and re-adapt to multiple drivers, triggers and situations. From this perspective, affect decentralises emotions from an internal and private set of feelings, into effects or triggers (Leith, 2019, p.503) that can potentially be analysed as part of the process of observation.

It is precisely this openness to understanding complementary ways in which individuals construct knowledge that allows Gherardi (2017, p.348-349) to point out that since the 1990s some scholars have started to investigate affect as a valid parameter to take into account within the construction of knowledge, and in that sense she defines affect by providing three cardinal aspects found within the broader literature, of which the following is highlighted as pertinent to this investigation:

“It is an assemblage of potentialities, located outside the narrative, which augment or diminish the individual’s capacity to act or engage with other agents (human or non-humans)” (Gherardi, 2017, p.348).

This definition highlights two important aspects of affect that are relevant for this investigation. The first is that affect enables possibilities beyond the circumstantial, physical constraints or material arrangements. The second is that it enables and opens internal pathways by behaving like a new source of emerging alternatives, or motivators in Savolainen’s terms (2014). This is due to its liminal and “immaterial capacity”, as Gherardi (2017, p.355) explains.

For Gherardi (2017) affect as practice is not restricted to the circumstantial forces in which individuals find themselves, but relates to a number of capacities and potentialities, body states and cultural understandings and socio-material relationships that allow the individual to adapt or respond to particular triggers or gaps in her understanding. Gherardi (2017, p.349) also highlights, that in a Schatzkian approach, only humans are involved in affective practices, while, on the contrary, she defines affect as the “capacity of interaction within a sociomaterial practice” (Gherardi, 2017, p.353). I will return later to the inclusion

of non-humans in relationships where information practices occur.

That affect is not constrained by the context only, opens the potential for agents to be affected by domains beyond the boundaries of the site observation.

Authors such as Gherardi, Olsson, Lloyd and Leith, who have investigated and theorised on the importance of affect for the construction of knowledge, provide along with Schatzki's teleo-affective structure, a foundation to understanding a component frequently overlooked in studies about knowledge and information and that is the incidence of the emotive factors in our understanding.

I will summarise aspects of Practice Theory that I draw on to this point.

Practices are socially constructed and are embedded in a social environment, they are collective, and are part of a group's routines of interaction, being persistent and repeatable. They are observable in the sayings, doings, and relationships of people. The knowledge that is created and shared through interactions is not only cognitive but is also embodied and affective. Now, I turn to the concept of site, which is an important notion when trying to move further than the local dynamics of the site under observation.

Site Ontology in Schatzki's Practice Theory

Site is particularly important for Practice Theory, and specifically from Schatzki's perspective, as the main context where practices "take place" and human interaction occurs. Schatzki introduces us to the idea that sites are similar to concepts from other scholars, such as Bourdieu's concept of field (Schatzki, 2002, p. xxii), but he specifically elaborates a framework where practices emerge within the context of meaning, relationships, understandings and teleological constraints.

"Site Ontology" provides a way to understand the contexts where human activity and interactivity take place (Schatzki, 2002, p.86), circumscribed within doings, sayings and relatings of human interaction (Schatzki, 2003, p.176). Schatzki identifies three types of site where human practice evolves within material arrangements. The first type of site is "where" practice can be located

on the time-space axis within a larger set of circumstances (Schatzki, 2002; 2003, p.176). This type of site is perhaps the easiest to grasp, and where the majority of Information Practices research is focussed. It is where the activity has a time and a place where it occurs and can be identified. Schatzki's second type of site is a broader site where "phenomena" occur. This type of site might not be delimited by the boundaries of a particular time-space location, as it could be physical or virtual and could spill across multiple locations and timeframes. However, it maintains its cohesiveness due to the overarching moods or emotive capacities and shared meanings, including the knowledges in disciplines, provided by the context (Schatzki, 2002, p.64; 2003, p.177). Finally, the third type of site is where the practices in themselves are the constitutive factor of the site or context, therefore this type of site could be located in a physical space, or spread across time-space, but is identified by the performance and stability of activities and interactions as the predominant aspect that provides the site its identity (Schatzki 2002, 2003).

In the following paragraphs I illustrate these three types of Schatzkian site through some studies that have influenced this investigation, identifying ways in which the concept of site will be important for the conceptual development of my study. Beginning with Schatzki's first type of site, in Latour and Woolgar's description of the laboratory in *Laboratory Life* (Latour & Woolgar, 1986), it is possible to see a clear illustration of site as location, where activities came to pass at a particular space and time, both in the physical distribution of the laboratory, but also in how their practices were performed within spaces that have certain moods, habits and modes of practice associated to them.

An example of Schatzki's second type of site (2002, p.64), where activities happen as part of larger phenomena, rules and understandings, can be found in Pickering's work in *Constructing Quarks* (1984). This type of site can transcend physical and even temporal frames, as the activity is located across a larger set of inter-related rules, physical sites, historical events and patterns of knowledge. In this work Pickering examines in detail how quarks were accepted as a reality, even before they could be confirmed with evidence, by painstakingly analysing

the practices of the scientists within high-energy physics. He is able to trace the acceptance of “Gauge Theory” as an authoritative picture of the reality of quarks by the scientific community, in part due to a common practice in understanding elementary physics in terms of composites (Pickering, 1984, p.406), and in part because of the growing collaboration between theoretical and experimental physics. These developments happened progressively and collaboratively across the discipline, by a gradual set of practices, in terms of understandings, meanings, analogies, theories and experiments (cf Schatzki, 2002, p.64).

Schatzki’s third type of site is, as he puts it, more “rarefied” or esoteric. Whereas the first two types are separated from the practices of individuals, in this third type, site is where those practices are constituents of the site itself, in other words the practices are the binding element that makes the site distinctive (Schatzki, 2002, p.64). The abstract nature of this third type of site may make it difficult to grasp. An illustrative example from an Information Practices perspective could be provided by Yerbury et al.’s (2022) investigation of information practices in a Sri Lankan Buddhist temple in Sydney NSW. Here, site in this third sense, allows us to understand the particular social place, in which practitioners of this faith share common practices associated with a place, but at the same time going beyond and across national borders and time, thus enabling them to have a particular identity, regardless of their geographical displacement.

Knorr-Cetina’s (1999) *Epistemic Cultures* offers another instance of such “context” or “site” in Schatzki’s terms (2002, p.65). Her investigation in two different scientific laboratories – biology and high-energy physics – permitted Knorr-Cetina to elicit the concept of epistemic cultures, which describes the very configurations and dispositions in which different cultures or groups of scientists build authoritative knowledge (Knorr-Cetina, 1999, p.1). Her investigation describes the practices and understandings that emerge distinctive to each group and setting. This finding allows Knorr-Cetina to point out the heterogeneity of science, and the situational practices that in themselves provide the meanings and understandings, that give each culture their cohesion

in their own practices and identities. This concept will be explored in greater detail below, as it offers a contextual elaboration particularly relevant for this study.

Schatzki's ontology of site (2002; 2003), presents itself as an appropriate framework to evaluate practices and the context to grasp the level of cohesion under which members of a group work together. More importantly, Schatzki's site ontology offers a conceptual space, especially with sites of the second and third type, to consider practices beyond the confines of physical boundaries. Such concepts as site, context, flat ontology and the "nexus" of practices, which have been part of Schatzki's thinking since 2002 (Schatzki, 2002, 2016), will enable this research to view the implications of sites beyond the laboratory where scientists carry out their research, allowing the researcher to view a more complex and greater scope than the physical location where observations are carried out.

Latour's Conceptualisation of Site

It has been useful for this study to identify examples of each of Schatzki's type of site. These examples have shown how central the notion of site can be for a study of the information practices of scientists. Each has also shown that what is important is linking the concept of site to an understanding of practices. Latour and Woolgar's study, uses the simplest definition of site, but their notion of practices is far more complex than this would suggest. In my study, I seek to go beyond the limited notion of site found in most Information Practices research, to uncover a more nuanced understanding of the links between site and practices. To do this, I return to Latour and Woolgar's study of *Laboratory Life* (1986) to explore the implications of ANT. As described so far, Schatzki's Site Ontology (2002; 2003) is core to his theory of practice. It is represented in the doings, sayings and relatings of participants (Schatzki, 2002, p.72), that share common contexts, understandings and meanings, and it is at the same time what makes up the site and gives cohesion to the participants, while acknowledging that those practices, meanings, rules and understandings are

socially based, dynamic and evolving constantly.

Latour (2005), however, has a different initial preoccupation. He takes a site and uses it to create a different understanding of social interaction. He is critical of what he calls “Sociology of the Social” because he sees unjustified leaps in social explanations that explain hidden effects and relate them to global or macro causes. Instead, he proposes what he calls a “Sociology of Associations”, in which he recommends via his ANT method (Latour, 2005, p.165) a way to unfold the multiple sites and to track the associations of actors across sites. His theory of association is based on a model of translation and performance. What this means is that actors, participants who are engaged, will connect and work together as a product of their relationships. In other words, the social is what it comes as a result of associations, actions and the dynamic relationships among participants (Latour & Woolgar, 1986, p.276; Latour, 2005, p.165). Although both Schatzki and Latour take a performative approach, Latour’s view of the social is, thus, different from that of Schatzki’s. For Schatzki, participants are already socially bound by their interactions in the given site, whereas for Latour, it is the interactions that lead to social bonds.

Here, it is relevant to introduce a key feature of ANT. ANT is particularly known because it acknowledges that non-human actors can influence social environments, what is sometimes known as the socio-technical or socio-material context (Van House, 2004; Palmer & Cragin, 2008; p.18; Huizing & Cavanagh, 2011, p.1). Thus, from Latour’s perspective, human and non-human actors are both engaged in interactions and therefore are indistinguishable. For Schatzki, even though non-human entities may be involved in “chains of actions” (Schatzki, 2003, p.198) they remain part of the environment.

The importance of the social in Information Practices encourages me to explore further Latour’s understanding of social relationships and site. Latour proposes keeping the social “flat” (Latour, 2005, p.175). To explain his conceptual approach, he adopts a metaphor using a cartographic approach. This allows him to present multiple sites in a single plane of action, where associations can

be unfolded, and actors can be examined transporting agency through sites. In order to demystify such “social structures”, which are assumed by a “Sociology of the Social” to be the de facto cause of social effects, through his Sociology of Association, he argues that global sites are converted into local sites through a number of moves, that enable him to unpack such structures into one flat landscape, illuminating the links amongst actors and their associations that actually bring about effects within the “network”.

At one level, the ideas of site held by Latour and by Schatzki are similar. However, the differences in focus and interests make their definitions of “site” slightly different. Schatzki’s purpose is to identify the activity first and the chains of actions second (Schatzki, 2003, p.198). On the other hand, for Latour (1986; 2005) identifying how action is transported by agents and changes occur is crucial to account for agency, which in turn identifies sites of interaction. In summary, both authors understand site and its relationship to practices differently, and even though both views are performative, in that it is the actions of actors and their activities that delineate the site or network, the focus for Schatzki (2002) is the activity or practice itself, while for Latour (2005) the focus is in how that agency is transported or carried from site to site.

Horton’s Cosmic Zoom - Moving Across Sites

It has been important to elaborate the distinctions in understanding of site for these theorists because an understanding of site is critical for this investigation. However, I do not want to set up a binary divide, establishing the idea that I must choose between Schatzki’s approach or that of Latour, because I note limitations to each. McKenzie’s (2022) keynote presentation at the Information Seeking in Context conference, held in Berlin in 2022, provided a way to move forward. In this talk, she presented the concept of the Cosmic Zoom as a way of exploring context and drawing boundaries around information practices. This concept, she argued, allowed researchers to understand how individuals “change their institutional roles, privileges and responsibilities when they inter- and intra-act with informational objects” (McKenzie, 2022). This concept

appears not to have been taken up yet in research in information practices. Thus, I sought out the film by Robert Verrall (1968), that McKenzie identifies as her starting point, and other literature on the concept, in particular Horton's book, *The Cosmic Zoom*.

Horton's (2021) work, *The Cosmic Zoom: Scale, Knowledge and Mediation*, helps to operationalise McKenzie's (2022) concern of research on information practices limited by the boundaries of local environments, which she expressed as follows: "However, as a research community we have struggled with exactly where – at what scale – to draw the analytical boundary delineating context" (McKenzie, 2022, p.2). Horton lays a foundation that can work in agreement with Schatzki's Practice Theory and Latour's ANT, without having to collapse what appear a multiplicity of domains working simultaneously on participants. What Horton argues is that human "milieus" tend to appear as contiguous to human understanding, when in fact they are mediating apparent discontinuities in scale (Horton, 2021, p.90). The potential implications of Hortons' position, is not only that thinking in scale is valid, but even necessary, when, as McKenzie (2022) highlights, local and situated practices where participants are at the centre of the action, could have traces linked to external domains.

I took the idea, based on Schatzki (2002) and Latour's (2005) conceptualisation of site, agency and practice, that it is possible to position action at different sites, simultaneously, and these can be conceptualised as existing at different levels, so that local practices can at the same time be embedded in broader contexts. I was attracted to this aspect of the concept, as it operationalises Latour's (2005) precept that the researcher should follow the participants wherever they go. Schatzki's observation that practices are evident in the sayings, doings and relatings of people, and the findings from Information Practices, taken together suggest that as people talk about what they do, they may evoke other settings that bring another layer to their practice. Therefore, I saw value in the concept of Cosmic Zoom, and its interpretation of site of observation, in particular of its ability to trace clear distinctions between the site where observations are performed, and other sites that seem to appear through

participants' accounts. From this perspective, the site of investigation, the laboratory, can be seen as Verrall's "home-frame" (the boy in the boat), coincidental with the physical location, Schatzki's first type of site, and other sites can focus on more micro or more macro settings from a perspective of magnification.

The introduction of the concept of Cosmic Zoom has given me a different perspective to explore in more detail Schatzki's and Latour's perspectives on site, which because of their conceptual roots in a flat ontology, I suggest, has led to the focus on a home-frame analysis in Information Practices.

In Practice Theory, Schatzki (2016, p.28) views the social dynamics manifesting in a single plane of action or level, they rely on a flat ontology, as noted above. Interaction between actors and the development of relationships favour a more local view of social analysis, rather than a view of social level and causes occurring at different levels. Similarly, Latour's ANT method (2005) also proposes a flattening of the social landscape, by exploring the actual interactions between actors and how agency is transported across sites. Latour (2005, p.131) explains that his opposition to scalar approaches is due to the possibility that global causes obscure the action of actors participating in sites, in lieu of structural causes that explain the actual social dynamics and associations taking place.

The capacity to move across sites, from the micro to the macro, suggests a scalar approach. Distrust of a scalar view is ontological, that scales are presented as fixed and hierarchical levels of reality (Jensen, 2021, p.1). The application of a scalar approach often pushes down causes to lower levels, and could impede the actual determination of causes, which Latour argues can readily be identified via a thorough examination of associations at the site itself (Latour, 2005). However, drawing on Latour, when we understand at a local level of analysis that group formation is a dynamic process based on its performative capacity, which in turn depends on the ability of actors to maintain relationships and perform activities (Latour, 2005, p.35), it seems hard to

explain how local sites do not exhaust themselves, leaving them to wither as quickly as they emerge, unless they are capable of bringing new impetus to the local site from external sources through their own actors which are connected across multiple domains.

Latour is further critical of the use of fixed scales because they are conceptually set up a priori, therefore preventing sociologists from actually investigating how the social phenomena come about by association of actors. Horton (2021) analyses scales, knowledge and mediation, and in his analysis of the different types of abstractions about scales he proposes scales as a form of difference which he names “scale alterity”. This allows him to see scales as a way of understanding relations between different domains (Horton, 2021, p.6), a point of importance for me in this investigation. On this point, Horton and Latour coincide in agreeing that scale is a subjective mode of framing the world, as Horton puts it a “reflexive form” for subjectively ordering the world (Horton, 2021, p.11).

Nicolini (2009) also adopts the terminology of the zoom. He acknowledges the importance of understanding practice at the situational level and in real-time, but nevertheless, he also indicates that it is important to account for “trans-local phenomena” or practices across domains (Nicolini, 2009, p.1392). Nicolini proposes a metaphorical approach he calls “Zooming in and out” (Nicolini, 2009), which attempts to use a number of conceptual frameworks and methodologies including how ANT to connect local practices, with macro or larger circumstances or other localities and practices (Nicolini, 2009, p.1395) to attain a more multi-dimensional view of practice. It is important to clarify that for Nicolini (2009), even though his use of various conceptual frameworks aims to identify practices beyond the local context and within other localities or domains, his metaphor’s application is different. For Nicolini, the changing of lenses means the changing of theoretical framework to bring other aspects of practice to the foreground. My interest differs from that of Nicolini; it is in using the notion of zooming in or out to refer metaphorically to adjusting the frame of magnification to go from meso to micro or macro contexts, by following the

participants' accounts.

In addition to the literature of Practice Theory, I considered the work of researchers who have carried out studies of scientists and their engagement with the creation of information and scientific knowledge, going beyond those grounded in an Information Behaviour approach. Here, I found the literature of Science and Technology Studies (STS) beneficial. Pilerot, Hammarfelt and Moring (2017) include STS as a potential field that can contribute to information science in both method and theory; this is also proposed by Van House's (2004) review of STS and Information Science, because of the use of Practice Theory in many of the contemporary studies.

In the work of Latour and Woolgar (1986), Pickering (1984; 1995), and Knorr-Cetina (1999), there are concepts and insights that influence my understanding of the topic. They are important to my understanding of practices in scientific laboratories, and I will explore their contribution to my thinking in the next section.

Science and Technology Studies

Science has a prominent position in society regarding the creation of knowledge (Knorr-Cetina, 1999, p.1). Yet there has been surprisingly little research on the information needs, behaviours and practices of scientists within Information Science (Jones, 2005; Huvila & Gorichanaz, 2025). Shaw's (1948) report on the information needs of scientists is cited as the first study that explores this topic along with other studies published in the subsequent decade (Wilson, 2000, p.50). Chen's 1974 investigation, 'How do scientists meet their information needs', came to be regarded as a well conceptualised study in the newly emerging area of information needs. A number of descriptive studies of the information behaviours appeared in the 1970s and 1980s– mostly use of informational resources – and mostly locally-based case studies. Palmer's (1991) research on the personal factors of scientists in Information Behaviour broadened the base of these studies, linking to the broad approach to the

development of studies of Information Behaviour and the factors that affected it.

Van House (2004), seeking to further extend the base of studies in this area, argued that Science and Technology Studies (STS), as a sociological discipline, views science as a knowledge creation practice no different from any other socially constructed phenomenon, and exhorted scholars in Information Science to become engaged in the research and dialogues being undertaken within this field of sociology, to establish an interaction between these two fields.

One of the benefits that STS can bring to Information Practices research, she indicated (Van House, 2004, p.4), is that scholars from information science focus on practices for the construction of knowledge, and in doing so, they take a social approach, viewing science not as a special discipline, distinct in its creation of knowledge, but as another social enterprise where knowledge is constructed through social dynamics (Palmer & Cragin, 2008).

I take up van House's exhortation to strengthen links between Information Practices research and STS. Given the paucity of studies of the information practices of scientists (Huvila & Gorichanaz, 2025), there is much to be gained by analysing key concepts and approaches from this literature that are relevant to the conceptual base of a study of the information practices of scientists. In this section, I draw on the work of the following: Latour, Knorr-Cetina, Pickering and other authors in information science, identifying concepts that extend the repertoire of Information Practices research and Schatzkian Practice Theory.

Latour and Actor-Network-Theory (ANT)

I begin with Actor-Network Theory (ANT), which has been influential in shaping my conceptual understandings. The use of ANT enables researchers to explore the complexity of associations and how agency is transported through relationships. In their seminal work Latour and Woolgar (1986) performed an anthropological study of scientists at The Salk Institute for Biological Studies. As a social observer, Latour (Latour & Woolgar, 1986, p.12) became part of the life of this laboratory for two years, with occasional duties that made manifest his

dual status as an insider/outsider and which permitted him to observe, follow and analyse the culture and the social dynamics at the interior of the laboratory. One of the main findings in this work (Latour & Woolgar, 1986, p.69) is that the observer, i.e. Latour, identified that the main output and objective of the laboratory was the production of academic papers, and in so doing, the laboratory was organised in such a way as to constantly consolidate or solidify the facts for the production of knowledge and scientific essays.

Through their investigation, Latour and Woolgar (1986, p.71) came to view the laboratory as a writing enterprise, with the perennial effort to bring order to the production of findings captured from technology, experimentation and observation, via document entities that could be circulated across the environment. They (1986, p.63) point out that such evaluation and elucidation of the final facts into authoritative pieces of knowledge in academic papers are not only the product of the scientific method, but also the product of social negotiation, as facts are discussed, evaluated and finally made explicit in the final version of the paper (Latour and Woolgar, 1986, p.69).

When Latour and Woolgar (1986, p.105) proposed that scientific papers contain the construction of facts from research, Latour is not implying that knowledge in a paper is fictionally elaborated, but that the facts of what is known are put together after being decanted through social interaction. However, this generative process is mostly hidden from the final version of the academic papers, which gives the impression that facts were only the direct result of scientific reporting on direct observation of the phenomena.

The work in *Laboratory Life* (Latour & Woolgar, 1986) has been significant for the present research, as a forerunner of this type of investigation and a model in how to implement a methodological approach as a social researcher interacting with biologists. One of the main differences, however, that one can appreciate is that modern laboratories, compared with laboratories in the 70s, have less emphasis on writing, virtually no presence of secretaries or typewriters are observed in modern laboratories. There is a greater emphasis on capturing,

managing, and organising information coming directly from devices into storage, for subsequent analysis.

Latour's ANT has been at least as important for the conceptual development of this study as has the literature of Practice Theory. *Laboratory Life* (Latour & Woolgar, 1986), gave me a concrete example of how a study of the practices of a scientific laboratory might be presented, and how appropriate concepts might emerge and be developed. It is not surprising, therefore, that concepts from that work, play a role in the development of this study.

This investigation uses aspects of ANT to frame this study. Latour defines ANT mostly as a methodology rather than a philosophical view (Latour, 2017, p.8). This is not to say that ANT makes no ontological or epistemological claims about the social environment and the actors that populate it. ANT's ontological and epistemological position, methodological tools, and vocabulary showed me how information practices are constituted by this group of scientists for the construction of knowledge.

A key factor in ANT, however, is the position of non-human actors. I understood that using ANT does not imply that objects have will or are sentient, but rather, that objects are not simply suspended in the backdrop of human reality, but that they have the ability to influence the dynamics of a social context (Harman, 2018; Bryant, 2018). From an Information Science perspective (Van House, 2004; Palmer & Cragin, 2008; Pilerot et al., 2017) the introduction of this socio-material dimension is useful to identify how information practices could be instituted, not only due to work constraints or life circumstances, but also due to the constraints imposed by the footprint that non-human actors have in our everyday practices.

Adopting this position expands the scope of the social landscape and enables me to include actors previously omitted from many practice-based studies. Further, Latour argues that actors cause ripple effects on other actors and those effects could be transformational (Huizing & Cavanagh, 2011, p.5). A consequence of including different types of actors is that it makes the social

landscape more complex, bringing a number of new dimensions into the research (Latour, 2005; Harman, 2009).

Latour's concept of agency is similarly important to my understanding. His work in *Reassembling the Social: An Introduction to Actor-Network-Theory* (Latour, 2005) is critical to his "Sociology of Associations" view (Latour, 1984), as the study of how agency is transported by actors. Latour's views on relationships, interaction, negotiation, and ultimately agency, are based on his notion of relationism (Harman, 2018; Bryant, 2018). He attempts to overcome the traditional Kantian subject/object divide by denying that actors have an essential core to their being, arguing that instead they reveal themselves as they truly are, through their relationships. In other words, actors are what they appear to be when they display themselves to other actors, and in a network those actors that have "agency" will transfer information and transform the environment by the strength of such a relationship (Latour, 1984; 2005; 2004). From this, I understood that information transactions among actors' relationships, in the shape of practices, are core to the constitution of a network and infuse the site with dynamism as actors modify and influence each other and their context.

The emphasis on the associations between actors is not presented in terms of power as authority or force, but instead, in the capacity of participants to enrol others, negotiate and to "translate" agency to have an effect on others. There is nonetheless the implication that actors in the network have the power to make changes. This idea is largely missing from the literature of Information Practices, although it seems fundamental. In other words, for Latour it is not the structure of the network that binds actors together, rather it is the interactions and relationships themselves, as actors work with others, which creates the structure.

One of the most important contributions ANT has made to my conceptual understanding, is that agency can be transported across distinctive sites through the action of agents, whether humans or non-humans. Latour proposes that sites can transfer their agency or impact to other sites thanks to having

actors in common, which are able to transport and transform the sites via their actions. I found this claim to be insightful, although, as explained above, I do not accept Latour's (2005) "flat ontology" or cartographic view of site's connectivity, that attempts to unfold every actor involved in a site connection, so as to avoid explanatory leaps of social causes (as explained earlier in this chapter).

From this conceptual point, I understood why Latour puts his emphasis on methodology. He explained that in order to track these relationships and their impact, or to identify actors that have any type of influence on the network, it is important to take an ethnographic approach, and he proposes a vocabulary set that is designed to track agencies and their impact (Van House, 2004; Latour, 2005). I explain, in the next chapter, the influence of Latour's insistence on using an ethnographic approach on my own choice of methodology, although I have not adopted his vocabulary fully, finding it stilted and out of place in the context of information practices.

Knorr-Cetina and Her Epistemic Cultures

Knorr-Cetina's (1999) *Epistemic Cultures: How the Sciences Make Knowledge* investigated the practices of two independent groups of scientists for a number of years, a HEP (High Energy Physics) group of scientists at CERN and a group working at the Molecular Biology laboratory at the Heidelberg Institute and the Max Planck Institute. She and her collaborators used an ethnographic approach including interviews to become acquainted and to try to be part of the life of the laboratories and the practices by which knowledge is constructed.

Knorr-Cetina (1999) discusses how situational and socio-material factors determine the practices by which knowledge is generated. She developed the concept of epistemic cultures to label these practices. She found in her investigation that each epistemic culture, as she calls these scientific groups that converge through time and circumstances (Knorr-Cetina, 1999, p.1), develop their own practices through multiple negotiations, different drivers and constraints, sometimes also imposed by their technological devices, objects of study and their social dynamics. The temporal dimension to the group

formation, along with the circumstances, produce unique social dynamics and an environment where scientists establish practices and understandings, as they position themselves in continuous negotiations with their environment; both their circumstances and the objects can exert a certain amount of influence on them.

Knorr-Cetina (1999) concludes through her research in both locations, among other things, that science is heterogeneous and that the scientists in each epistemic culture will enact and constitute their own practices according to their own circumstances; in other words, scientific research is not a monolithic endeavour. She found that knowledge creation is situational, and therefore contrary to common belief on the homogeneity of science and the application of the scientific method. Thus, the construction of knowledge in academic papers obeys situational drivers and constraints. This heterogeneity of science is important for my investigation because it implies that knowledge within a laboratory is not only the result of private cognitive processes, but the result also of the social dynamics within the laboratory. It implies that the process for authoritative knowledge to finally be published via academic papers, travels through a number of feedback loops and processes in which grants, authority, science expectations, publications, journals and other social dynamics have a place in how knowledge and facts are finally presented in academic papers, as Latour and Woolgar (1986) also noted.

This view of the creation of knowledge, according to Knorr-Cetina (1999), is not only social, but also embodied, recognising that each group or “culture” interacts with its environment differently. The microbiologist directly dissecting mice use a different range of embodied postures, which are distinct from scientists in HEP laboratories, who are various degrees removed from their phenomena of study while interacting with sensors and apparatus, in that way obtaining a symbolic understanding of the information obtained from the mediation of technology and instrumentation (Knorr-Cetina, 1999, p.127). She showed how the technology and the objects of study are not simply suspended and serving as a reflection of human cognitive knowledge (Harman, 2018), but

that they are participants and have a force that either opposes or affords scientists the opportunities to build such authoritative knowledge, to the point that at times these objects are viewed with anthropomorphic attributes and even endowed with moral characteristics. The idea she conveys is that there is not one science done one way, there is a scientific method, and science is made in multiple ways, according to the profile, circumstances, and members of each culture.

She also (1999) acknowledges the plethora of non-human actors that can have multiple influences on a culture, even though her analysis, for the most part, is contained within the laboratory walls. This interpretation of the concept of epistemic cultures is useful for my study, giving me a basis to understand collective practices from the accounts of individual scientists. A question remains for me about whether an epistemic culture and the knowledge created through it is only the result of internal dynamics or if the boundaries of the concept can be extended to include external pressures.

In presenting the concept of epistemic cultures, Knorr-Cetina identifies the contextual aspect in which knowledge is produced and the necessary and localised nature in which practices are constituted. She sees the laboratory as a controlled microcosm of the natural order, a staged representation of real processes where the parameters are managed. The technological devices or the objects of study are reconfigured within the laboratory depending on the information or influence they wield on the observer's understanding. Knorr-Cetina acknowledged the heterogeneity of science, but at the same time, her focus on the laboratory leads me to consider it as a disconnected bubble, when in reality, it may be part of a greater interconnected set of sites where common actors are able to transport information and influence across multiple domains, bearing an influence on the local network, a network of knowledge production (cf. Latour, 1984; Horton, 2021).

Her work shows that it may be important to consider the situational aspects of knowledge construction within the laboratory, however, it may also be important

for social researchers to trace actors which have a transformational effect in the domain, moving information and influence across multiple sites (cf Latour, 2005, p.220). This could help to elucidate how external pressures affect information practices and social processes at the interior of the site; thinking in these terms could reveal a picture where a network of sites began to emerge, with common actors among them, that are able to move information and agency across (cf Horton, 2021, p.10).

This type of actor, that has the ability to move across sites and transfer agency, is considered a mediator in Latour's terms (Latour, 2005), because they have a transformational power. That is the case of the sensors and other instrumentation inside the laboratory in Knorr-Cetina's study. In Knorr-Cetina's (1999, p.47) case, the detector and sensors achieve a number of transformations to represent the microscopic level of reality to the frame of the observer. The device's importance and its influence are validated by how the scientists refer to it, how they care for the object and how they assign to it anthropomorphic qualities, something that Knorr-Cetina (1999, p.111) refers as the behavioural and physiological aspects of the devices. She (1999, p.126) refers to the scientists and their interaction with the devices in the laboratory, particularly within the HEP investigation as "symbiont", a word she uses to illustrate how intimate and interdependent the relationship between scientists and their objects of study could become. This enables her to say that there are temporal associations, in which not only is the object ontologically "reclassified" within the environment as an actor, but that scientists are also categorised based on their expertise and level of competence handling the object; their knowledge becomes more integrated and there could be even a level of pride based on their expertise, which once again is based on this close relationship.

The seminal work of Knorr-Cetina (1999) in *Epistemic Cultures: How the Sciences Make Knowledge*, is important for this investigation because it provides an STS antecedent for a study within a scientific laboratory, with Practice Theory as a conceptual framework and ethnography as methodology. But also, her insight about the heterogeneity of science and situational

development of localised practices, could be an element of importance when analysing the practices of the scientists involved in this investigation.

Furthermore, another notion of importance is the predominance of technology and the re-classification and anthropomorphising of devices as participants within the information practices that generate knowledge.

Pickering and His Dance of Agency

For Knorr-Cetina this symbiotic relationship with the instrumentation is tangential to her notion of epistemic cultures. However, an author within the STS tradition that examines closely such interactions between the scientists, and their instrumentation or objects of study is Andrew Pickering. Having previously been an elementary-particle physicist himself (Pickering, 1995, p. ix), Pickering became discontented with “realism” as an explanation for knowledge creation. He explains how, now as a social scientist, he began to investigate how knowledge relates to practice and the material world (Pickering, 1995, p. xii), focussing in particular on how physicists created theories about the nature of matter and reality, socially and through their interactions with objects.

In his two books, *The Mangle of Practice* (Pickering, 1995) and *Constructing Quarks* (Pickering, 1984), Pickering makes a historical account in which he argues that scientific knowledge is not only the result of observation of the phenomena, but that it is constructed through the institution of social practices and traditions via a process of modelling or analogy, while negotiating with non-human actors in the laboratory.

The two books can be read as a departure from a positivist and cognitive or realist view, to a more social constructivist view of knowledge. Specifically, in his book *Constructing Quarks*, Pickering (1984) traces the history of how the concept of quarks emerged socially, as much as experimentally and theoretically. He (1984, p.5) traces the acceptance of the reality of quarks as the basic blocks in the constitution of matter, even though not observable at the time, and offers an account of how theories and methods are socially accepted via experimentation, theories and social progression of acceptance.

In *The Mangle of Practice* (1995), Pickering traces the development of physicist Giacomo Morpurgo's Bubble Chamber to find evidence for the existence of quarks. In so doing, he delves into the reciprocal interaction between the material entities and scientists as a process of negotiated agency.

The choice of the word "mangle" for Pickering (1995) is quite deliberate; in both of its uses as a noun and as a verb, it evokes the disruptive and almost violent process of the old laundry machine. Pickering uses it to demonstrate the intertwining between material agency, human agency and conceptual thought within scientific practice, not as an easy process of assemblage, but as the struggle of the dialectic process of "resistance" and "accommodation", a process of repetition and relentless small changes. With its use, he strongly conveys that there is such a thing as "material agency" or non-human agency, that affects the production of knowledge, and that scientists need to contend with it through time and space to arrive at their goals, such as the construction of knowledge. *The Mangle of Practice* (Pickering, 1995) demonstrates how the relationship with objects leaves traces in both the scientists and the objects, as they shape each other through their interactions.

In explaining the concept of the mangle, already a metaphor, Pickering (1995, p.24) uses the metaphor of the dance, more specifically the "dance of agency" as a way to illustrate the pull/push dynamic between the scientists and the objects in their investigations. The use of such an illustration is helpful to me because I was brought up in a culture where dancing is important. It is recognised as a communicative process; even if there is a leading partner, the success of a dance is that both partners are able to read and negotiate the cues while dancing. A partner can break or indicate the ways in which he or she is willing to navigate the song, and the counterpart needs to accommodate or lead if they want to achieve a joyful and aesthetic result. Dance is a partnership endeavour, in which each participant is source and recipient of the influence of their partner. In the same way, Pickering's concept, the dance of agency, evokes a temporary assemblage in time and space, in which both scientists and objects collaborate and oppose at different stages to produce knowledge as a

result of their association.

This investigation will assimilate the metaphor of the dance of agency, as a starting point to understand the influence of the microscope as a critical technology for the group of scientists who are the focus of this study. The concept brings the opportunity to recognise the impact the device has on their practice of observation; how it affords to the group the opportunity to get closer to observe the bacteria. The use of this concept in the process of analysis will highlight the device's influence on their discoveries, their knowledge production and the papers they published, and ultimately the extent to which they go to care for, accommodate and interact with this entity.

This concept of “resistance and accommodation” (Pickering, 1995), is an element of the dance of agency. Pickering concludes that there is an action-reaction effect to the relationship between the scientists and the world they want to study, in which all participants influence each other; for instance, in the case of the Bubble Chamber, the object will present hurdles and obstacles to the scientists' goals, forcing scientists to navigate or negotiate the object's obstacles.

Pickering's historical analysis in *The Mangle of Practice* (1995) is developed at a micro level of analysis. In other words, *The Mangle of Practice* focuses for the most part on the interaction between the scientist and the machine, and even though there is a discussion about the implication of big science and small laboratories, the concept of the mangle of practice is, for the most part, restricted to the immediate and temporal relationship between the scientists and the instrument. This focus on the immediacy of interactions between scientist and machine, and the notion of resistance and accommodation will add another layer of complexity to my understanding of these interactions.

Haider and Kjellberg and Preserving Objects as Data through Time

Haider's and Kjellberg's investigation (2016), *Data in the making: Temporal aspects in the construction of research data* in Sweden's research facilities (ESS and MAX IV), considers questions about data across multiple axes of time and explores the question of how objects mutate from fixtures of reality into stored data. Their investigation examines the use of technology to support the big research laboratories for the production and preservation of data as an emergent object of their research, and how the scientists' observations and data obtained from the different devices are transformed, stored and preserved through time (Haider & Kjellberg, 2016, p.143).

They seek to understand the "magical moment" when objects become data distributed across devices, facilities and affecting people across time (Haider & Kjellberg, 2016, p.152). In my interpretation, this concern can be linked to ANT's concept of transformation and agency, something that Latour encapsulates under the term of "immutable mobiles" (Latour, 2005, p.223); in other words, documents or artifacts that encapsulate observations, findings or information in general that can be transported across sites. These transportations and transformations, in Latour's parlance (Latour, 2017), highlight how phenomena can be mutated or trans-formed via the agency of multiple actors and can be mobilised through multiple sites (cf Knorr-Cetina, 1999, p.81). However, in this instance Haider and Kjellberg also add emphasis on time as a dimension, indicating that such transformations into data can also have an effect through time, as the data are stored and maintained for other researchers into the future.

Their insight about transforming objects of reality into data to be maintained through time, and thereby its potential effect to other scientists in other geographical domains and into the future, had an impact on my thinking and provided further strength to Latour's concept of associations and transformation across sites (Latour, 1984, 2005). Their ideas sharpened my view that sites

might not be independently siloed, but that actors and technology can have impact across domains and move information, not only across the spatial planes, but also across time.

Antonie van Leeuwenhoek and Observation

Observation is central to much scientific research. One fascinating case that could illustrate STS views on knowledge construction in scientific practice was brought to my attention by the leader of the laboratory and therefore I include it here. Antonie van Leeuwenhoek (1632-1723) is considered the father of the microscope and microbiology (Karamanou et al., 2010, Kutschera, 2023) and he is in many regards a key influence on how the practice of observation was viewed and performed by the group of scientists in my study.

The significance of van Leeuwenhoek is his simple approach to observation, direct and physical engagement with his objects of observation. Van Leeuwenhoek's work was critical for the development of the microscope. Being a textile trader, he used lenses to magnify the textile threads, and he himself developed lenses with better magnification. His curiosity led him to observe the world around him. Van Leeuwenhoek was not a scientist, nor did he have any formal education (Karamanou et al., 2010); he wrote primarily in Dutch and many of his findings were known via the Royal Society of London. However, through the span of his life, he is credited with many findings including spermatozooids and red blood cells among many other discoveries; he examined his own teeth and discovered what he called "animacules" now known as bacteria (Kutschera, 2023).

Van Leeuwenhoek's approach to observation and investigation illustrates many aspects discussed throughout this chapter. For example, it illustrates Pickering's (1995) idea of the dance and how non-human actors can shape conceptions about the world. Van Leeuwenhoek's work could also be illustrative in another sense of the heterogeneity of science (Knorr-Cetina, 1999, p.3). He illustrates the processes of observation and repeatability, but the ways in which he implemented them were by no means typical of a standard laboratory or the

scientific community. Instead, they were done according to his life experiences.

Without the information from the leader of the laboratory where I carried out my observations, I probably would not have known of the work of this 17th century Dutchman. He was not a scientist, yet his practices of observation and the recording of these observations in the everyday language of the time, captivated my imagination and provided me with many opportunities to think through the practices of contemporary scientists.

Conclusion

The literature review discussed the major perspectives, scholars and academic literature that had a notable impact in this investigation, with the objective of understanding the relevant background for this study and the potential gaps where this study can contribute. The chapter began with an examination Information Practices and the authors who have used social perspectives within Information Science to propose novel ways to think of knowledge and information practices as a social phenomenon. This discussion showed how these ideas have brought to this investigation the possibility of comprehending information processes beyond a cognitive perspective, and provided a picture in which individuals interact with their environment holistically, providing grounds for this research to consider the embodied and affective dispositions under which scientists may react and adapt to their environment, by modifying or instituting new information practices as part of their everyday life in the laboratory.

The chapter continued with a discussion of the foundation that Practice Theory provided to the conceptual framework of this study, in particular Schatzki's Practice Theory. This section discussed how Schatzki's social view of practice provides support to understand embodiment and affect, which are important elements for this research as discussed before. The chapter also discussed the contribution of Schatzki's Site Ontology to build an understanding of the site of practice for the analysis of scientific practice. This section analysed both

Schatzki's and Latour's ANT conception of site and their flat-ontology position, which renders the analysis of sites, and their practices limited to a single level of scrutiny. This is contrasted with other views in the literature that provide a certain degree of freedom for researchers to investigate information practices from a broader context than a local perspective.

The final section of this chapter reviewed the literature in STS and some of the most prominent studies that have been used as models for various aspects of this investigation. These studies in scientific laboratories included the work of Latour and Woolgar (1986), Knorr-Cetina (1999), Pickering (1984; 2017) and of Haider and Kjellberg (2016). This section elaborated concepts that are significant for my understanding of the complexity of information practices. I included the case of Antonie van Leeuwenhoek, as an influence on the practices of the group of scientists participating in this research and their practice of observation; but it also served as an illustrative case of situational epistemic practices (Knorr-Cetina, 1999) and the impact of non-human agency on the construction of knowledge.

I have used this conceptual understanding of the literature to identify gaps and weaknesses in the literature, but also to demonstrate the complexity of the concepts that exists in the notion of information practices, such as embodiment, affect, and more specifically the ontology of site, which has an impact on this thesis. It is this complexity that excites my intellectual curiosity. Therefore, the research question that emerges from this review of the literature is a seemingly straightforward question: **What are the information practices of a group of scientists working in a university laboratory?** There are few studies of scientists and their information behaviours or information practices. There is also scope for greater clarity in how information practices are constituted, conceptually and empirically. Thus, this broad question will allow me to work with the complexity of the concepts and their interplay, thus adding to the conceptual development of the field.

In the next chapter, I present the methodological approach I used to investigate this question.

CHAPTER 3: METHODOLOGY

Introduction

This chapter presents the methodological approach adopted by this study. The study was carried out in a university research laboratory between August 2018, and July 2019 using an ethnographic approach and included six of the nine scientists in the research group. It begins by discussing the criteria for choosing an apt methodology for a study of information practices taking a practice theoretical approach. The section proposes ethnography as an appropriate methodology and justifies its selection, highlighting some of the predominant aspects of the methodology that were important during its implementation. These include the role that the researcher plays as a tool of inquiry, the requirements for gaining access to a culture in a closed setting such as a research laboratory, and the writing of ethnographic accounts, which is a distinct aspect of the ethnographic methodology and plays an important role here.

Through the subsequent section, I provide specific details of the data collection process, covering topics including immersion into the culture, observing and interviewing participants, making fieldnotes and gathering documentation. In addition, I reflect on some of the challenges and the importance of such methods for gathering data for this study.

The next section is concerned with analysis of the data, using content analysis and the innovative analytical tool of Cosmic Zoom (Krippendorf, 2004; Horton, 2021). I explain the development of this tool which was important for this study. The final section deals with the ways that quality was ensured throughout the study. That section concludes with reference to the approval granted by the university's Human Research Ethics Committee and its implications for quality in the study.

Choosing a Research Methodology

A decision to use a research methodology is not made in isolation. A methodology is chosen as an appropriate epistemological approach to answer a research question framed in a particular theoretical way. Having made such a decision, the social researcher then is able to make choices about data collection and data analysis informed by conceptual frameworks that shape the research question (Emerson et al., 2011, p.357; Krippendorff, 2004, p.307; Bryman, 2012, p.5). The research question for this study is framed in practice theoretical terms and influenced by the research of Knorr-Cetina and Latour.

The Practice Theoretical approach has been fundamental for this investigation into the information practices of scientists. Such an approach accepts a number of premises, and these must be represented in the research method chosen for the study. The Schatzkian Practice Theory (2002) provides a robust conceptual framework for understanding how practices are socially constructed within a context that influences the construction of knowledge and social dynamics in general, (Schatzki, 2002, p.174). These premises, then, are as follows: practice takes place in a context shaped by social rules; this context is not necessarily bound by the requirements of physical location (Schatzki, 2002, p.64) practice involve the interactions of people and non-human agents (Gullbekk, 2021, p.24,75), as part of a socio-material context; practice is made evident through the sayings, doings and relatings, “The Nexus of Practices” (Schatzki, 2002, p.58; Hui et al., 2017, p.4) of participants.

In the context of information practices, it is important to be mindful of how the construction of knowledge occurs at a social level, not ignoring embodiment and affect as viable components of how human agents interact with their social context to produce new ways of knowing (Behar, 1996; Lloyd, 2006, 2010; Olsson, 2010, 2016). Whereas a Schatzkian practice theoretical approach has been adopted in information practices research, with its focus on human actors, following Latour’s ANT approach makes it imperative to ensure that non-human

actors are also included (Latour & Woolgar, 1986; Van House, 2004; Latour, 2005; Harman, 2009).

Understanding the significance of social context beyond the physical boundaries of observation (Schatzki, 2002, p.64) is also an important aspect of the theoretical approach. This matches Latour's maxim that the researcher should follow the actors wherever they go (Latour, 2005, p. 68). Understanding site ontology and the constitution of practices at the core of the site (Lloyd, 2009, p.246; Pilerot et al., 2017, p.4; Huizing & Cavanagh, 2011, p.2) is fundamental to a practice theoretical approach.

Choosing Ethnography

Ethnography is widely used in information practices research as well as in what is commonly called "Laboratory Studies" (Latour & Woolgar, 1986, p.278; Van House, 2004, p.11; Schindler & Schäfer, 2021, p.13). At its core, ethnography entails the study of a cultural group and has traditionally required the researcher to systematically become immersed in a culture to observe directly and obtain first-hand data from the new environment (Geertz, 1973; Atkinson & Hammersley, 1994; Hammersley, 2002). Malinowski (1922), an innovative scholar, who pioneered the ethnographic method by physically immersing himself, living in the Trobriand Islands and interacting with the Trobrianders (Erickson, 1985), was responsible for the shift in anthropology, placing emphasis on immersion to witness firsthand the social interactions and behaviours of the people involved. This focus on interactions and behaviours in their context has been widely adopted by ethnographers and is crucial for this study.

Ethnography is primarily concerned with the social interactions and behaviours of groups of people, as exemplified by Malinowski and Mead's initial work (Malinowski, 1922; Mead, 1928). Their period of immersion, which allowed them to experience the social dynamics firsthand, became a standard in ethnography. The method is also concerned with the details of those interactions, the social

practices, which may have implicit agreements and rules that are contextually relevant, as they provide coherence and cohesions to behaviours and group expectations (Atkinson & Hammersley, 1994, p.248; Schatzki, 2001, 2002, 2003; Hui et al., 2017; Hammersley & Atkinson, 2019, p.19).

In general, ethnography encompasses a number of steps for the collection of data (Atkinson & Hammersley, 1994; Fetterman, 2019; Bryman, 2012, p.432; Hammersley & Atkinson, 2019, p.3). These include getting access to the culture or social setting; immersing oneself in the culture; observing the people and their environment; carrying out interviews with informants; taking field notes; interacting socially with the new environment; and gathering relevant documentation. These steps guided implementation of the methodology.

The ethnographer is in effect a tool of enquiry within the research process. Therefore, it is a given that the ethnographer has an impact on the environment, and that the environment has an influence on the ethnographer. As a tool of enquiry, ethnographers do not simply immerse themselves within the environment, processing information detached from their human condition, but being both a tool of enquiry and a human being requires them to make relationships that are conducive to obtaining an understanding of the social dynamics of the group. This process of understanding, as Geertz (1973, p.17) points out, is not detached or simply procedural and goes beyond the collection of data. Ethnographers, in order to gain understanding of the set of meanings and implicit rules that provide cohesion to the observed group, must establish connections and build relationships to exchange information with those they want to observe and understand (Hobbs, 2001, p.212; Mason, 2002, p.44; Flick, 2009, p. 109; Van Maanen, 2011, p.84). In this sense, early and seminal work such as Malinowski's (1922) and Mead's (1928) demonstrated that being an ethnographer is being a tool of enquiry.

Ethnographers have the responsibility of representing a group of people through their findings (Atkinson & Hammersley, 1994, p.253; Hammersley & Atkinson, 2019, p.11), but they cannot do that without truly engaging with the new context,

a process that may produce a tension between the different roles they assume, trying to maintain their distance while at the same time immersing themselves into the context. Stressing such a position, Behar (1996, p.5) highlights the paradox of “participant observation”, of participating while at the same time being asked to maintain distance and neutrality.

This realisation brings into question the roles the ethnographer assumes, not only through the observation process, but also in the interpretative analysis and the writing of those observations. What is obvious is that the presence of the ethnographer is not neutral to the environment (Geertz, 1973, p.194-195). The interpretative scope that the ethnographer has through the written accounts (Hammersley, 2002, p.6; Hammersley & Atkinson, 2019, p.3; Camayd-Freixas, 2020, p.46) should be acknowledged (Geertz, 1973). Geertz’s (1973) seminal work demonstrates that ethnographers interact with a mosaic of meanings that represent what holds a particular group together (Geertz, 1973, p.6), and that ethnographers achieve this, not only by describing the observation of such behaviours, but by imbuing themselves with the symbolic world of meanings originally foreign to them (Geertz, 1973, p.5).

During the present investigation I have experienced a dual tension in what I call my different roles as ethnographer. It seems to me, as a new ethnographer, that I was not only fully immersed into the social context as a social scientist only, but fully immersed as a human. My body and emotional reactions to what I was witnessing, and my attempts to build rapport, were also having an effect on my understanding and interpretations. My role as a tool of enquiry, that furnished some of my accounts a more confessional tone, as some of the findings demonstrate, was not a narcissistic attempt to write about myself within the ethnographic accounts (Bourdieu, 2004), but rather an organic, and even an ethical necessity, as claimed by Behar (1996, p.5). This process enabled me to disclose the messiness of human relationships via reflexive methodology (Hammersley & Atkinson, 2019, p.29), which makes one’s pre-conceptions, assumptions and biases evident, acknowledging that one’s immersion into the culture as an observer, has some methodological imperatives, such as making

human connections necessary for the collection of data, but that are, by no means, innocuous in their effects on the observed environment and the observer (Van Maanen, 2011, p.46; Latour & Woolgar, 1986, p.20).

This dual positioning of the researcher, as both being a participant and being an observer, brings a torrent of insights, experiences, understandings and emotions, and testifies to the changes ethnographers experience when immersing themselves into a new culture (Clifford & Marcus, 1986; Behar, 1996; Bourdieu, 2004), and the way their experiences and relationships inform their notes, interviews with participants and the quality of the data obtained (Emmerson et al., 2011). I found myself many times consciously maintaining a distance, in order to identify the salient points of the information and scientific practices of the participants, but at the same time, the rapport that we built meant that I could enjoy the incidental conversations that may have started from aspects of their scientific practice (Van Maanen, 2011). In other words, I was not simply a gathering data machine, nor a dispassionate observer, but an ethnographer acting as a tool of inquiry, and therefore, I was affected by the environment in many ways as already explained (Geertz, 1973; Clifford & Marcus, 1986; Behar, 1996; Bourdieu, 2003; Van Maanen, 2011; Emerson et al., 2011).

The main advantage of the ethnographer overtly acknowledging these dual positions is that the data collected, especially through the fieldnotes, is richer and more nuanced (Atkinson et al., 2001, p.3; Mason, 2002, p.88; Ritchie & Lewis, 2003, p.2; Emerson et al., 2011; Skinner, 2012, p.9; Denzin & Lincoln, 2018, p.1427). It recognises that inevitably the researcher has an impact on the environment being researched, and does not seek to limit unduly that impact, but to be aware of it and document it when it is observed.

Ethnography is both the written outcome and the researching method (Van Maanen, 2011, p.1). The written ethnographic accounts are interpretative representations of the culture (Van Maanen, 2011, p.8). The ethnographic accounts present the findings that the social researcher has drawn from the

culture in textual form. Such accounts may use styles that determine the rhetorical strength of the researcher's argument and the findings and interpretation of the culture, and how such findings illustrate, in this case, the information practices of this group of scientists in the laboratory and their investigations (Clifford & Marcus, 1986, p.6; Bryman, 2012, p.462).

Van Maanen's (2011) work is critical for this investigation as he identifies the different types of ethnographic styles in which the writing could be presented: the realist, confessional and impressionist approaches. The realist tale is what he defines as an authoritative text, whose most recognisable characteristic is the invisibility of the author (2011, p. 46). Confessional tales, on the other hand, are characterised by a personalised approach (2011, p. 73). He argues that the researcher's responsibility is to tell the story of the people whose world he had investigated, and in doing this, Van Maanen (2011, 1995) argues strongly against a predominantly scientific, constrained, cold and distant style for the presentation of findings in ethnographic accounts. He proposes that the style of writing offers to the narrative a rhetorical position that should not be restricted by a single, widely accepted, positivistic style. He suggests that language can be used in multiple styles and in new ways to display the feasibility of the accounts that the social researcher wants to present about the reality of the culture studied, thus providing greater freedom to the researcher to write and express his findings, impressions and representations of the culture (Van Maanen, 1995, p.134).

Style does not constrain or undercut theory but increases modes or ways to represent the reality of participants (Van Maanen, 1995, p.134) and that the suggestive flair of literary styles can also convey meaning (Van Maanen, 2011, p.34). I used two stylistic approaches to present the findings. Accepting the freedom offered by Van Maanen, I explored his reference to vignettes as a way to communicate "being there", "which is the means and end of the writing" (Van Maanen, 2011, p.132). Thus, I have chosen to write the majority of the Findings as vignettes, having first presented the information practices of the scientists in a more conventional way. The vignettes present the context in a descriptive,

realist, tone. This stylistic device is important to this study for two reasons. Firstly, it allows the information practices to be presented within their cultural context, rather than separated from the context as they are in the first section of the Findings. Secondly, it allows the ethnographer to make transparent his role as a tool of enquiry, by mostly using the third person voice but including some vignettes using the first person voice, demonstrating that the ethnographer is an active part of the social context (Geertz, 1973; Clifford & Marcus, 1986). Crapanzano (1986, p.51) indicates the ethnographer has a rhetorical place in text, and Behar (1996) has advocated for the ethical necessity of ethnographers to make themselves evident. The use of the first person in some of the vignettes allows for a reflexive voice (Geertz, 1973, p.195), something of myself in the work (Bourdieu, 2003, p.281).

The second stylistic device is the use of the literary style of Marvellous Realism. The use of a literary style in general, but particularly the use of Marvellous Realism, is not that farfetched an approach in the writing of ethnography (Taussig, 1992, p.2; Juschka, 2003, p.93; Van Maanen, 2011, p.22). In his chapter, *Primitivism, Ethnography and Magical Realism*, Camayd-Freixas (2020, p.46-47) points out the similarities between ethnography and marvellous realism as a meta-discourse which has multiple literary recourses to display hidden realities. It is important to emphasise that Marvellous Realism does not mean fantastic or fictitious (Bautista, 1991, p.20) but is a style that exhibits reality with great detail of description, together with the many half-acknowledged levels that are valid constituents of the “mystery” of reality (Bautista, 1991, p. 20; Zamora & Faris, 1995, p.3).

This literary style has been characterised as providing a faithful description of how individuals see their realities (Camayd-Freixas, 2020), not only in a technical manner, but including the way they experience it (Zamora & Faris, 1995). Elements sometimes apparently out of the ordinary are represented, and the impossible, the everyday, the extraordinary from other spheres of experience and daily life are part of the expressions of the individuals (Bautista, 1991, p.19). To recognise the significance of the observation of the everyday,

Gabriel García Márquez, from whose literary work most English speakers are familiar with Marvellous Realism, used to call the approach “social realism” (Zamora & Faris, 1995, p.4) so as to highlight that the genre explores how individuals experience their lives. Therefore, and perhaps naturally (Slemon, 1995 p.9-24), my use of Marvellous Realism grew organically through the narrative as a way to unveil and integrate those other domains of interaction, that connected scientists and the many other domains where they live.

I will note here that I grew up in Colombia, where the works of Gabriel García Márquez, the major Colombian exponent, are well known and studied in school and at university. Marvellous Realism presented me with what seemed to be a natural way not only to describe reality, but to integrate different aspects of how the scientists in this study perceive their reality, full of other less obvious, but yet important, aspects of their environment.

Such a richly descriptive, multi-layered approach follows Geertz’s (1973) approach of immersing himself in the meanings and symbols of the culture, but even in a more important sense, it follows Clifford and Marcus’s (1986) proposition of the use of text and narratives as the means to convey the reality of the context (Behar, 1996, p.5; Van Maanen 2011, p.1). In this sense Marvellous Realism afforded me, as a social observer, the opportunity to bring hidden domains of interaction into the narrative, as the participants themselves experienced them and brought them along in their technical accounts or their scientific practices. Those hidden but real and present aspects of the life and practices of scientists would have been discarded as incidental in a positivist account (Van Maanen, 1995, p. 133).

Given this overview, ethnography appears to be an appropriate methodological approach for an investigation which uses a practice theoretical approach, as It affords the researcher the opportunity to be part of the social context, to witness the social practices, the behaviours and to attempt to understand or interpret the implicit set of contextual rules and meanings that provide cohesion to its members. It takes into account the engagement of the researcher in the

research process and is sensitive to the way that interpretations are made and findings are written. In summary, ethnography permits the social researcher using conceptual frameworks like Practice Theory the opportunity to be part of the social context, aiming to understand and witness firsthand its social life and dynamics (Fetterman, 2019; Bryman, 2012; Hammersley & Atkinson, 2019).

In particular, for this investigation, ethnography allows the researcher to witness directly the information practices of scientists within the scientific laboratory (Latour & Woolgar, 1986; Knorr-Cetina, 1999; Van House, 2004). As Knorr-Cetina puts it, ethnography allows the researcher to observe the “drama of real life unfold[ing] in real-time”, the daily routines, conversations, relationships, interactions with technology and experimentation and other activities that are performed within the social context (cf Malinowski, 1922; Mead, 1928).

However, it is important to acknowledge that ethnography also has its disadvantages. The most significant is that it is time consuming to become immersed into another culture and witness the local dynamics. It can take a long time to be accepted into the cultural group (Malinowski, 1922; Mead, 1928; Hammersley & Atkinson, 2019). Further, to ensure that observations are complete and accurate requires patience and the understanding of any cycles of activity within the group (Geertz, 1973; Clifford & Marcus, 1986). Another potential limitation is researcher bias, that is, the tendency to privilege interactions with some participants over others and to favour some observations over others during data collection and during analysis (Erickson, 1985, p.84-85; Clifford & Marcus, 1986, p.18; Hammersley, 2002, p.4), thus bringing to the data a preconceived idea of key themes. A third limitation concerns generalisability. Generalisability of research results is not an appropriate way to evaluate the outcomes of an ethnographic study. As Guba and Lincoln (1994) noted, transferability is more appropriate. The rich description of the context and the findings (Geertz, 1973) provide a basis for the transferability of these findings to other, similar, groups.

Ethnography in Other Studies

In a general sense, as discussed above, ethnography requires social researchers to imbue themselves with the foreign culture, interacting firsthand and gathering information by various means for later analysis, with the ultimate purpose of writing the ethnographic accounts that will contain a faithful interpretation and representation of the culture within the frame of the selected theoretical approaches. Two laboratory studies by Latour and Woolgar (1986) and Knorr-Centina (1999) provide clear examples of engagement in a scientific culture to observe and learn directly from the context.

Latour & Woolgar's study, *Laboratory Life – The Construction of Scientific Facts* (1986) is foundational within STS and influential on my decision to use ethnography. Their approach was ethnographic, as they themselves explained. Latour immersed himself in the scientific laboratory (The Salk Institute for Biological Studies) for a period of over two years (p.18). During this time, he acted in an observing capacity, although on occasion, he also had some tasks assigned to him within the laboratory. He also collected documents and performed interviews with participants as a means of gathering data (p.39), in addition to making field notes containing his observations and reflexions (p.37). In this ethnographic study, he dived into the scientific culture as a means to understand their practices and beliefs (p.27), feeling a palpable dichotomy between being accepted as an external researcher and feeling part of the local context at times. The approach to research through this investigation allowed Latour and Woolgar to understand the purpose of the scientific laboratory as the production of academic papers. Their main concern was in how the social construction of scientific practice can give birth to scientific facts about the phenomena. Latour and Woolgar recounted their findings through a character called "the observer". This is, without a doubt, a significant stylistic decision about how to present their findings (Van Maanen, 1995). It could be said that this decision allowed them to gain some critical distance. At the same time, it allowed Latour to present his impressions with a reflexive tone. through a proxy

character (the observer) that allows the reader to understand how the environment was shaping Latour's knowledge.

During the course of the investigation, the researchers discussed the basics of their ethnographic approach, as it became what they called an "anthropology of science" (Latour & Woolgar, 1986, p.27). They displayed a meditative tone in describing the emotions or different perspectives and at times the inadequacies of the observer entering, interacting and immersing himself within the new culture. They used the figure of the observer as a narrating device, presented in the voice of a third person character, which provided some separation from them and the character they used within the narrative to describe the environment and its social dynamics.

The use of ethnography allowed Latour and Woolgar to observe that constructing authoritative knowledge in an academic paper, involves not just reporting findings, but actively constructing them. This process requires social and material interactions. These socio-material interactions include interpreting and debating devices' data, experiments' results and theories, all these interactions go through a number of loops to negotiate which findings are finally presented in a scientific paper (Latour & Woolgar, 1986; Van House, 2004). This work has been influential for my own decision-making in the use of ethnography. In particular, the use of the observer as a character that provides a voice to their ethnographic accounts through which the findings are narrated was beneficial, as it gave me an example of how to use such a literary device to provide a richer ethnographic account. It allowed a more organic and natural voice and prompted me to consider the use of other literary devices, including writing vignettes using Marvellous Realism, as described above.

The second pillar that influenced my decision to use ethnography for this investigation was the work of Knorr-Cetina, *Epistemic Cultures – How the Sciences Make Knowledge* (1999). Her work on *Epistemic Cultures* as the localised and socialised practices for the construction of knowledge, was the result of ethnographic fieldwork carried out in two branches of science, High

Energy Physics, performed in two laboratories, UA2 and ATLAS at CERN (Switzerland), and Molecular biology, carried out in the Max Planck Institute in Göttingen and the Heidelberg Institute (Germany). This large-scale investigation required a number of different fieldworkers, but with two main ethnographers in each location, collecting data, carrying out interviews, taking fieldnotes, observing and engaging with the environment. The ethnographic work done in these two branches of science, allowed Knorr-Cetina and her ethnographers to observe how each scientific group was able to create their own way to make science, with localised approaches to interacting with their study objects and technology. These mechanisms emerged contextually and are susceptible to their own social dynamics. These observations allowed Knorr-Cetina to challenge the idea that science is monolithic. She instead proposed that each group builds their own epistemic culture, based on their own circumstances and goals (Knorr-Cetina, 1999).

These ethnographic accounts, even though less reflexive than those from Latour and Woolgar (1986), still highlighted some of those feelings of dual positioning that entail being an external observer trying to dive into a new social environment. The accounts and presentation of the findings are less personal and more conceptual, with only some tangential comments about the methodological considerations of the role of the investigator. Instead, what is clear in Knorr-Cetina's accounts is the voice of the participants with quotes from their interview, from which the researcher infers key findings throughout the text.

Knorr-Cetina's approach of bringing to the fore the quotes of the participants was very helpful for my own approach, and I have adopted a similar style to bring to the forefront of my vignettes the voice of participants, using their own words and in some case my fieldnotes, using them as a springboard to drive the elaboration of various points in the interview and observational data. Another aspect of her work that was pivotal for me was her description of the ethnographer as "a life instrument" (Knorr-Cetina, 1999, p.23). This led me to

consider the fieldworker as a “tool of enquiry” that informed all aspects of my methodology.

These two studies have been important points of reference throughout this investigation for the use of ethnography as a methodology. Both studies were situated in scientific laboratories, and the presentation of their accounts has provided important models in how to implement this methodology of ethnography in a scientific laboratory. An evaluation of these studies enabled me to build on them. I was able to adopt the dual position of the scientist, as a tool of enquiry and as a human establishing relationships within the environment. This approach frames the twofold position that other authors have discussed, between being an external observer and the tendency of preventing oneself from going local when getting used to the social context (Latour & Woolgar, 1986, p.29; Pratt, 1986, p.38; Pollner & Emerson, 2001, p.121). That dual positioning also highlights the fact that the researcher is not purely an omnipresent eye but affects and is affected by the environment (Clifford & Marcus, 1986, p.12; Haraway, 1988, p.581).

Such duality and contraposition were a point of reflexion to determine how to better reflect reality through the ethnographic accounts, as noted above. The potential conflict was resolved by opting to present the findings in the form of vignettes with a mixture of first and third person voices to present (mostly) realist tales, as proposed by Van Maanen (2011).

Putting Ethnography into Practice

To reiterate, the investigation site for this study was a research laboratory located in a major metropolitan university in Australia. Its website identifies a focus on discovery research and applied research, and the team of researchers is multi-disciplinary. Some of the scientists in this group are starting their careers, but others have established careers. This diversity has facilitated the development of several strands of research, involving collaborations among the scientists. From background information gathered, it is clear that the scientists

have used a number of technical strategies and tools to study an entity that is not accessible via direct examination, the bacterium.

This section presents the experience of using ethnography as a methodological approach for the collection of data. This starts with immersion in the culture to be studied. I consider the importance of accessing the environment. Various scholars confirm (Fetterman, 2019; Ritchie & Lewis, 2003; Bryman, 2012, p.433; p.62; Hammersley & Atkinson, 2019) that aspects of negotiating access or gaining access to closed environments are critical and difficult without sponsors, relationships and various approvals that may require negotiation. This step is extremely important as it highlights constraints in terms of ethical approval and certain commitments that the researcher will need to meet.

Accessing the Research Culture

One of the critical aspects of any investigation for which ethnography has been designated as a methodology is to negotiate and obtain access to the site of observation or the culture (Mason, 2002, p.91; Flick, 2009, p.106; Bryman, 2012, p.433; Hobbs, 2001, p.205; Hammersley & Atkinson, 2019, p.44). The need for a well thought out strategy to gain access, identify gatekeepers, and enlist sponsors and champions, is crucial. Such negotiation to gain access may be protracted (Smith, 2001, p.226; Van Maanen, 2011, p.84), as was my experience.

Finding sponsors or leveraging contacts can be crucial to gain access to a closed environment like a research laboratory (Ritchie & Lewis, 2003, p.62; Van Maanen, 2011, p.4; Bryman, 2012, p.435). I was fortunate that one of my supervisors has an extensive network and I was able to leverage her contacts. That was crucial in gaining access to the laboratory and the group of scientists, a step that began with a meeting with the leader of the laboratory, referred to throughout by the pseudonym, Professor Karen. The introduction to Professor Karen was the first of many steps, any one of which could have prevented me from gaining access to the laboratory and the group.

Following an informal meeting with Professor Karen, she asked for a formal proposal to her as the leader of the group, seeking approval to perform a social investigation in her laboratory, where research with significant commercial and societal impacts is undertaken. At this point, I began the lengthy process of seeking approval from the university's Human Research Ethics Committee to conduct the study. This involved (Bryman, 2012, p.83, Denzin & Lincoln, 2018, p.573) requesting formal letters of approval from various offices. Only at that point could I make a presentation to the scientists about my research, in the hope of enlisting participants.

Enlisting participants into my study was the next step in gaining access to the culture. Because my ethnographic implementation was overt (Emerson et al., 2011; Bryman, 2012, p.433), meaning that participants would know that I was an external observer performing social research, and due to my ethics approval, the participation was to be voluntary. To avoid any coercion, I presented my project proposal to the whole group of scientists and invited them to freely participate without exerting any pressure. That meant that not all the members of the research group agreed to take part, but those who did, six out of nine scientists in the group, were happy and enthusiastic about taking part. In this, Professor Karen, the leader of the laboratory, was my sponsor and champion, and she coordinated a meet and greet with the group to present my research, letting team members know that she was supportive of my project.

Before I could begin data collection, there was still one more potential hurdle, the training program required to ensure that I was aware of how to behave in the laboratory, given the inherent dangers involved.

Data Collection

Ethnography conventionally uses several methods of data collection. These include as a start, the immersion of the ethnographer in the culture. This immersion continues throughout the study while data is gathered through observation, interviewing, the making of fieldnotes and the collection and

analysis of a range of other documents, as listed below in the section Gathering Documentation (Flick, 2009, p.234; Bryman, 2012, p.432; Hammersley & Atkison, 2019). Each of these data collection activities is outlined below.

Immersion Into the Culture

Immersion into a culture involves more than being familiar with the physical environment (Malinowski, 1922; Mead, 1928; Hammersley & Atkinson, 2019). It began before I entered the laboratory as I consulted a range of documents. Although I used these documents at various points during the data collection phase, the group's website, media interviews, social media presence and their academic papers were all essential for me to immerse myself in their culture in the early stages of the study (Krippendorf, 2004). Through these documents, I gained familiarity with the scientists and their research, and I learned the language they used to communicate ideas about their work, both to the general public and to other scientists. This meant that once I had the full approval to enter the laboratory and had met the bio-safety training requirements, I was able to participate in informal lunches in the social area, shared by various teams, and to move through the different areas, albeit never by myself. My access was always dependent on having one of the scientists who had agreed to participate with me. These lunches, social interaction in their social area, and group meetings, were other ways for me to enter into the life of the laboratory. In a way, it felt like wearing somebody else's shoes, and as a researcher, I found it was exciting and daunting at the same time. Nonetheless, it was an excellent way to get to know the scientists and experience their social life, even though it provoked in me a sensation of living on the edge, of being a native and an external observer, constantly reminding me of what I had read about the position of the ethnographer.

Observing the Scientists and Their Environment

Among the approaches to data collection, one of the most prominent is what is usually called in the literature 'participant observation'. However, it would be

more accurate to see it as the involvement of the social researcher within the cultural context to be a part of social interactions of members of the group; this could involve having assigned activities or only being an external observer (Atkison & Hammersley, 1994, p.248; Flick, 2009, p.226; Latour & Woolgar, 1986, p.20). Such participation, if negotiated and granted, as explained above, can determine how the observer is perceived by the group which could raise questions about the level of overtness and freedom with which participants will perform their day-to-day tasks (Atkinson & Hammersley, 1994, p.248; Bryman, 2012, p.434; Hammersley & Atkinson, 2019). Enacting such an “in-situ” presence is more than a technique. Atkinson and Hammersley (1994) argued that it is a “mode of being-in-the-world”. Being an observer involves in a holistic fashion the humanity of the researcher, and this has implications for how accounts of what has been observed can be presented. Observation relies on the social observer as a tool of enquiry, but the presentation of the researcher’s accounts, how the social reality is presented to peers and general readers, is also reliant on the observer and the ability to interpret and represent what is observed (Geertz, 1973; Clifford & Marcus, 1986; Atkinson & Hammersley, 1994, p.254; Van Maanen, 2011, p.1), as has been discussed above.

Observation was a key aspect of data collection in this study. I had the opportunity to be present through observation sessions with the four participants who were performing experimentation at the bench or with the microscope. This allowed me to follow the participants through the laboratory, wearing the white coat and the goggles, so that I looked like them. An important concession to me was that even though computers were not allowed in the experimentation area, I had permission to use my mobile device to record each session. I observed the scientists while preparing experiments, performing experiments, interacting with various devices, microscopes, students or colleagues. There was no pre-defined format for these sessions, and it was free flowing, following the scientists through her or his normal day-to-day tasks.

Despite my objective of being a “fly on the wall”, to cause the least disruption, the scientists were obviously conscious of my presence and tried to describe

their process or objectives as they progressed through their experiments and observations. Occasionally, I felt the need to formulate a question, where I felt that I was out of my depth, and I could not understand what was going on at a high level, in spite of having read relevant research papers as part of my preparation. I do not think that there was any reactivity, in other words, acting differently because of my presence, as warned by Bryman (2012, p.436) but also exemplified and discussed by Latour and Woolgar (1986) through their investigation. The scientists seemed to be comfortable enough with my presence, as to proceed with their tasks, but it is undeniable that they accommodated me and made an effort to describe their processes. This was beneficial to the study, as it brought an unintended dimension to the data because from time to time the scientists used the opportunity to reflect on their practices and brought some other domains to bear as they verbalised their actions.

Interviewing Participants

Interviewing is an important component within ethnography (Kvale, 1996) that along with participant observation offers the social researcher key opportunities for collecting data (Mason, 2002, p.55; Ritchie & Lewis, 2003, p.20; Bryman, 2012, p.469). The method of interview employed throughout this research ranged through the types of interviews that Skinner (2013, p.8) would call conversational and semi-structured. An advantage of this approach is that it allows the researcher to guide the topics of discussion but provides more control to the respondent in how the conversation flows. It gives opportunities for both parties, the interviewer and the interviewee, to construct the rhythm of the interaction, how it evolves and where it leads. As Kvale (1996, p.50) puts it, the interview is the “construction site of knowledge”, where dialogues between the researcher and participants take place. However, interviews also have their disadvantages. They take time and energy both for the interviewer and for the participants. Interviews, in general, have the potential for interviewer bias, where the interviewer imposes his or her view on the responses of the participant. Participants may provide the kind of answer that they think the

researcher wants to hear or that they think will present them well in the eyes of the researcher (Bryman, 2012, p.94; Hammersley & Atkison, 2019, p.109). The interviewer's approach, personality and communication style can all impact on the participant's willingness to answer fully.

Through this investigation, I began the interviews with semi-structured questions, to provide some starting points to initiate the dialogue. As time went on and our familiarity and trust in each other grew, the interviews became less structured but always focussed on the key topics. The scientists were encouraged to bring in any aspect that came to mind during their responses and descriptions of their practices. All interviews were recorded, and I did not take notes until after the session was over. In preparation for the interviews, I would also read academic papers or media statements or other articles published by the participants. This strategy proved beneficial, as it allowed me to introduce new ideas, break the ice, and clarify questions. Participants responded with excitement to me bringing their own papers highlighted to the interview and asking concise questions about their papers. This approach was received positively by participants and opened new avenues of discussion and commentary from the participants.

Taking Fieldnotes

Fieldnotes are a critical aspect of ethnography (Bryman, 2012, p.466). Within such a context, fieldnotes emerge as a critical factor for capturing not only memorable aspects of the social researcher's interactions and observations (Bryman, 2012), but also how the dual position of the researcher as a "marginal native" (Atkinson & Hammersley, 1994, p.249) has a moulding effect on the interpretative capacity of the social observer.

Taking fieldnotes is not easy, but they are a very important tool to preserve the memory of the events and the impressions from the interactions (Skinner, 2013, p.9). It is not always feasible or possible to take notes during the immersion in the field and interactions with participants, as Emerson et al. (2011, p.133) have pointed out. In my case, I perceived that it could be distracting for participants

and for myself to be taking notes all the time, and because all my sessions were recorded, I opted to place my attention on the participants and what was going on in the moment. I chose to go to a quiet place in the university right after the sessions and to type all my impressions into my electronic notes (cf Emerson et al., 2011). A risk from fieldnotes is that the researcher's memory is faulty, but this was an effective strategy and because everything was fresh in memory I was able to compile useful notes from my interactions with the scientists.

Fieldnotes were a great resource for me to capture my own impressions. The advice of Emerson et al. (2011, p.133) that on many occasions, jotting down notes could be distracting and suspicious and that field notes written up afterwards could be a helpful way to reflect on the environment and social dynamics of the environment was helpful. The field notes also allowed me to capture some informal events, including sharing lunch with participants, or chatting in the social area, or attending an internal meeting that could not be recorded. This resource helped me to hold my memories in a document for later analysis.

Gathering Documentation

Collection of documents is another important component of ethnography (Riles, 2006). Documents provide insight into how organisations build their knowledge, establish practices, are proof of organisational memory, record traces of agency and become artifacts that are transportable across sites bringing its influence on other actors (Latour, 2005). They solidify knowledge and become a point of reference for others (Tourney, 2003). According to Searle (1995, p. 119) documents serve as indicators of institutional facts for the construction of social conventions.

Many types of documents will be associated with a research laboratory, based within a university. These documents were not produced for the investigation but are artifacts that have been collected by the researcher. As they are publicly available for the most part, these artifacts are related with the investigations and discoveries from the laboratory (Bryman, 2012, p.543). None of the documents

collected is private, and mostly they demonstrate the type of research that the scientists do and how they share or move information from the laboratory into the wider world of science or into the wider society. As Riles (2006, p.22) points out, documents play an important role in ethnography to establish how social reality is constituted, as they preserve and record aspects of the culture. However, as she also comments, such artifacts may bring light to the interest of the research, the focus here being information practices and the construction of knowledge and the ways this group of scientists shared their knowledge outside of the group.

Latour and Woolgar (1986), Haider and Kjellberg (2016), and Knorr-Cetina (1999) all described collecting documents and artifacts for analysis. Gathering relevant data has been important for this investigation as the documentation gathered has provided more information about the participants, their objectives and their scientific investigations.

The following documents were collected in this study, some as part of the immersion process and others as a result of data collected through observation or interviews:

- Media articles published, which show how the scientists communicate their findings to the public.
- Public interviews, which also provided an understanding on how the group communicated advances and findings to a lay audience.
- The group's web page that explained the group's objectives and main research focus.
- Illustrations gathered from scientists during observations and interviews.
- Microscope movies demonstrating their research.
- Samples of notes taken by scientists during experimentation at the bench, which show how they took notes to be transported to the desk area.

- The social media presence of the scientists taking part in the study, which allowed me to become acquainted with their language and research.
- Academic papers written by the participants, which allowed me to understand their research, professional interests and to be prepared for the interviews.

The advantages of using sources of documentation are clearly documented by multiple scholars (see for example Bryman, 2012, p.543; Ritchie & Lewis, 2003, p.35). The main disadvantage is that the researcher has no control over the data itself, and this may be problematic because it has been compiled for a different audience with different purposes and perspectives in mind.

Data Analysis

Content Analysis

The use of a conceptual framework that enables the understanding and codification of the data is important. Krippendorff (2004, p.18) indicates that content analysis is a useful tool, and he stresses the importance of pairing such a tool with an adequate conceptual framework that could provide a perspective from which to illuminate the interpretation of the text (Krippendorff, 2004, p.29). In this study, the use of Practice Theory provided a conceptual framework, offering the social researcher the capacity to codify the text from interviews, observations and fieldnotes, and other documentation from the perspective of practices, relationships and agencies having influences in this laboratory. Consequently, the framework serves as the conceptual glasses for content analysis and interpretation of the data collected; in this way, many of the categories that emerge come as a consequence of the implementation of this conceptual framework, but at the same time, the use of the conceptual framework opens the door to new interpretations of the phenomena, providing readers an understanding of how connections were made and conclusions were reached.

Content analysis as defined by Krippendorff (2004, p.3) is a “systematic reading of texts, images, and symbolic matter, not necessarily from an author’s or user’s perspective”. This approach was chosen to introduce rigour to what otherwise could be a large amount of text, by coding and applying categories emerging from the conceptual frameworks systematically (Krippendorff, 2004, p.25). Through content analysis, the social researcher can identify categories or themes, or fine tune some of the *a priori* categories emerging from the data collected in conversations with participants and from previous studies. The process helps to validate new meanings, interpretations and patterns that could emerge and might not have been obvious at the beginning, giving way to more fundamental categories not evident on the surface, but part of the foundational substrate of the participant’s everyday practices (Bryman, 2012; Krippendorff, 2004).

NVIVO software was used to facilitate the analysis of the text and the codification of themes through data collected, which included interview transcriptions, recordings of observations, fieldnotes, and other documentation, including media material and interviews, the team’s web page, academic papers written by members of the group, and explanatory drawings and notes made by participants during some of the interviews or observation sessions. (These notes are worth mentioning because they provided additional context to the participants’ testimonies, as they became an internal witness of the processes and conceptual associations that occurred as the ideas became materialised and objectified in the form of a document, whatever its format (Buckland, 1991). This was perhaps a small component of their practices, but from an ethnographic perspective, it goes to show the importance of collecting additional material beyond that collected by the social researcher through interviews and observation.)

As themes arose through the text, they were codified into categories that began to reveal consistent patterns across most of the interviews and observation sessions and other data. These categories therefore indicated important themes and allowed less obvious themes to emerge through the analysis of the

categories on the collected data, for example, the persistence of data that pointed to other domains that were beyond the merely technical, to the more personal. Needless to say, the focus of the analysis of the transcriptions was to elucidate the information practices of the scientists in their own words. The type of content analysis performed on the available data involves conversational analysis, the qualitative analysis that involves the recording, transcriptions and analysis of such interactions (Krippendorff, 2004, p.16; McKechnie et al., 2006, p.2). Importantly, this analysis is fully dependant on the context of the conversation; in other words, the analysis must not be limited to the “representational content” of the propositions stated during the interview or observation sessions but needs to have a degree of awareness of the relational and contextual aspects in which such statements are made (Krippendorff, 2004, p. 67; White & Marsh, 2006, p.27). The holistic aspect in which such sentences are pronounced is critical. Importantly, understanding the statements of participants in this way allows the participants to reveal other aspects of themselves. However, it is important to keep in mind that the researcher is also part of the conversation, and this relational aspect cannot be omitted when analysing the text of the transcription by focusing uniquely on the representational and propositional content. This echoes Latour’s insistence on the relational character of ANT, in which actors are bound to affect other actors in the environment (Krippendorff 2004, p. 67; Latour, 1984).

In the case of the content analysis performed throughout this investigation, even though *a priori* categories may have been identified as a starting point, the iterative process, which involved a constant engagement with the transcriptions and recordings, permitted the social researcher to get re-acquainted with the tone and emotion with which the statements were pronounced. This constant engagement with the interviews and observation sessions afforded the researcher the possibility of capturing new categories as they emerged and illuminated more hidden themes that came to the forefront through a process of continual engagement with the source data (Krippendorff 2004). Qualitative data analysis, based on the coding of the raw text or data into categories, is a systematic process to try to suppress the researcher’s presumptions (Bryman,

2012, p.289). In this study, this time-consuming process was applied in a systematic and consistent fashion and was part of this reflexive and iterative process performed throughout the study.

Knorr-Cetina (1999) indicates how this approach allows the researcher to analyse the transcripts obtained from interviews, to understand how participants feel affected by their interaction with the phenomena under study or through their investigations more generally, and how they make sense of their everyday tasks. It also shows other aspects of their thinking, through their vocabulary both technical and symbolic, through their impressions and exclamations, aspects that could also illuminate other facets of their practices (Knorr-Cetina 1999).

The Cosmic Zoom as an Analytical Tool

Content analysis had allowed me to identify the major themes emerging from the interviews, observations and documents as they relate to information practices. However, I was aware that this was not a particularly useful tool to analyse the movements scientists made in and out of the different sites that I observed. Horton's book *The Cosmic Zoom, Scale, Knowledge and Mediation* (2021), as detailed in the previous chapter, allowed me to develop an analytical tool which I refer to as the "Cosmic Zoom" to identify these movements.

This analytical tool enabled me to identify how practices were affected in the laboratory – the home-frame – and by using the idea of magnification, which in itself was so important to the scientists, to zoom in and to zoom out, as it were, following the scientists "wherever they go" (Latour, 2005, p.68), even when they were not constrained to the physical boundaries of the laboratory in what they talked about. I was able to determine when the scientists were at the centre of their own practices or on the periphery of a different site. My use of Cosmic Zoom as an analytical tool, therefore, takes the accounts of participants at face value and follows the scientists' accounts, even to other domains outside the laboratory door. My use of the Cosmic Zoom as an analytical tool showed that

multiple circumstances and sites acted simultaneously on the practices in the laboratory. Schatzki himself proposes that the site of practice need not be bound by a physical place, and ANT also admits the reality of multiple sites converging on or influencing the network via the agency of actors common to multiple sites. Therefore, the use of the Cosmic Zoom made it feasible for me, the social researcher, to identify influences on the scientists at a local level, while taking into account the influences of other domains outside the boundaries of the site of observation.

The analysis showed, as the Findings elaborate, that on occasions the participant is affected by a domain external to the laboratory, say the system of grants, immigration or motherhood. All these domains may be external to the laboratory, but not all are located in the same scale of agency. Motherhood or family for example is a domain, external to the laboratory, which has great influence on the practices or decisions of the particular scientist, a domain where the participant may also be at the centre of agency. However, some other domains, such as immigration laws or the system of grants, also exert great influence on the scientist and her practice, but in these domains, the participant is not located at the centre of agency, she is at the periphery, on many occasions only feeling the repercussions of decisions made elsewhere.

Cosmic Zoom as an analytical tool has been fundamental in identifying the concept of Domains of Interactions as is presented in the Discussion chapter and indicating how the local is inter-twined with the broader context, so that it is clear that information practices are not happening in isolation only at the level of observation but can involve multiple sites and actors interacting on scientists simultaneously.

Ensuring Quality in the Study

Concerns and critiques can be raised about the soundness of the methodology and findings of any study. Particular concerns can be raised about ethnography. These concerns include potential observer bias overwhelming the voice of the

informants, the power relationships between the interviewer and the interviewee, the representation of the self and the stylistic choice in writing the findings (Atkinson & Hammersley, 1994; Van Maanen, 1995; Kvale, 1996; Emmerson et al., 2011). A social researcher needs to be aware of these and to take steps to avoid them or to minimise their effect in order to guarantee the quality and soundness of the study.

In the following sections I will address such concerns by focusing on the different techniques, their advantages and disadvantages and how I mitigated such concerns to ensure the quality of the research process, and the findings and conclusions presented here.

Being a Participant Observer

Ethnography requires the researcher to gain access to a distinct culture with the aim of acquiring an understanding of the practices, attitudes and social dynamics of the social group (Latour & Woolgar, 1986; p.27; Latour, 2005; Van Maanen, 2011, p.4), as noted above. This pre-requisite is necessary even before any technique could be employed to gather data, and as Bryman indicated (2012, p.433) could be not only critical, but perhaps also one of the most complex steps which could present many hurdles that need to be negotiated and overcome before any data collection can take place (Van Maanen, 2011, p.84).

To avoid any possibility that participants were being coerced to take part (Bryman, 2012), my approach was overt (Bryman, 2012), meaning that participants in the laboratory would know that I was a social researcher observing their activities. Even though my access to the laboratory was sponsored by the team leader, participation was voluntary and some scientists in the laboratory chose not to participate. This addressed the issue of coercion.

Nevertheless, the advantage of having participants being willing to volunteer does not cancel the problem of reactivity, a problem well known in ethnography. As acknowledged in earlier sections, the researcher's presence has an effect on

the environment that could make some participants try to present what they perceive as a socially desirable picture of their daily activities. To mitigate this risk, I made an effort to gain the trust of participants, finding bridges and points of commonality such as our common migrant experience, having a young family and being passionate about our research. This common human experience, I believe, was beneficial to facilitate the process of transforming participants into informants, by establishing relationships, so they could see me less as an external observer and more as a fellow human trying to do his own research (Bryman, 2012, p.439; Mason, 2002, p.94).

However, there was nothing I could do about the modifying effect of my presence, and I will not be able to deny that their environment had an effect on me and my knowledge. Nonetheless, being open about myself, and my background and objectives, seemed to bring a veil of normality to our interactions, meaning that I was perceived with less suspicion as time went by and the participants were more at ease with my presence, acting more naturally, and candidly, through our interactions and conversations.

Preserving Memories and Impressions – Quality in Fieldnotes

Fieldnotes are how ethnographers bring into words the social reality from the prism of their own experiences, providing a more durable medium (Latour, 2005, 226) so such memories can be revisited at a later stage. Van Maanen (2011, p. 2) states that the social reality is represented through the ethnographer's experience, as someone who lived in the social context and experienced the social dynamics even if as a "marginal native" (Atkinson & Hammersley, 1994, p.249). Ethnographers have to be cognisant of how to provide an equitable account of others, even taking into account that the representation is narrated from the perspective of their own experiences and interactions with the culture. To ensure that this was a measured and fair account, narrated from my perspective, experiences and interactions, I identified the types of memories I would record. Although I felt I was trying to

capture everything in my fieldnotes, in reality, I focussed on how the scientists presented themselves, the atmosphere, the environment, if there was resistance to my questions or engagement and excitement, as well as memorable things that produced any kind of connections for me, or further questions I had, including clarifications I needed, or the ones I obtained, and so on. It was important for me to remember that the interviews and observations were recorded, so the focus in the fieldnotes was on my reflexions as data.

Quality in Data from Observations and Interviews

In contrast with fieldnotes that are a record of an ongoing impressions and memories of how the social dynamics are experienced by the ethnographer, recordings of interviews or observations are a snapshot of a slice of the social environment (Emerson et al., 2011, p.104) from the participants or the context in general. Recordings are a great tool to freeze in time the observations and interviews, capturing a particular interaction or the impressions and reflexions of participants. However, the data collected can be susceptible to the quality of the recording, which can be affected by environmental noise, how the instruments for recording are positioned, and so on. Further, recordings are as good as their transcription, which, at least until recent times with the emerging of new technologies was a slow process (Knorr-Cetina, 1999). As Emerson et al. commented (Emerson et al. 2011, p.106), transcription implies a reduction, as it seldom is a faithful record of those non-verbal cues that could be part of the interactions, such as mannerism, intonations, body language or just the atmosphere in general.

Throughout this study and the data analysis, the recordings were a significant way to capture the interactions with participants and the culture in general. The interviews were held in a meeting room, which was quiet and away from interruptions, and it was conducive to focussed conversations. This contributed to the excellent quality of the recordings. However, recording observations in the laboratory was a different story, as it was an open and noisy space and I learned my lesson after the first interaction where the sound of the refrigerators,

the centrifuges and other devices made it hard to make out aspects of the conversation. To mitigate this, I used settings on the recording device that could filter the voice from other noises and this produced recording of the observations which were of acceptable quality.

Transcription of the observations and interviews was time-consuming. At the time, automated transcription (voice to text) was not particularly effective for recordings, and therefore some of the transcription was done by a commercial company, but all was checked and re-checked by me. This enabled me to re-live some of those moments, allowing me to capture aspects such as the excitement of the interviewee (or lack thereof), their voice tonality and other aspects that were absent from the transcription and to compare these recordings with my fieldnotes. This approach both ensured that the transcriptions were as sound as they could be and showed in the fieldnotes evidence of my own best judgement in documenting some of the intangible aspects of our interactions. The triangulation of recordings, transcriptions and fieldnotes ensured that my analysis and findings were based on sound data (Bryman, 2012, p.633; Mason, 2002, p.190; Ritchie & Lewis, 2003, p.43).

Value in the Documents

Data collection in this investigation is critical for the analysis of an environment, and the academic papers, public interviews, media articles, the group's web pages, or artifacts as illustrations, movies of the bacteria captured with the microscope, notes from experimentation intended to be moved to the desk areas are some of the examples of the documentation collected for further analysis, as described above in the section Gathering Documentation.

It is relatively easy to collect these documents, as they are publicly available. Mostly, the relationship between these documents and the study is clear. There may be a grey area in the use of a scientist's social media account because there may be personal and private material in a such an account. However, investigation showed that these social media accounts were set up to share information about the research project. Another potential disadvantage of

working with digitised versions of documents, particular those related to the media, is that the documents may be altered, or even disappear. I overcame that potential hurdle by creating an archived copy of the documents that were not archived elsewhere.

Ensuring Quality in Analysis

Quality in a qualitative study is usually judged according to four criteria, credibility, dependability, confirmability and transferability (Guba & Lincoln, 1994), although a fifth, reflexivity can sometimes be added. In this section, I set out these five criteria, showing how I have addressed them in the study.

Credibility is concerned with whether or not the findings of the study are believable and trustworthy. A study can be deemed credible when the ontological foundations of the study and the epistemological approach are well matched. That is to say, when the theory, the research question, approaches to data collection and data analysis, findings and conclusion are tightly linked, a study can be deemed trustworthy. As noted in this chapter, in this study, there is a strong link between the theoretical approach of the study and the methodology chosen, and further the methods of data collection are appropriate to the chosen methodology of ethnography. Data were collected over an extended period of twelve months, allowing significant time for trusting relationships to develop and multiple opportunities for data collection through interviews and observations, as well as the many informal occasions. Content analysis and then the use of the Cosmic Zoom as an analytical tool are in line with the identification of themes in an ethnographic study. The content analysis itself was conducted according to the processes identified by Krippendorff (2004), with care taken over the positioning of the ethnographer and the introduction of potential bias. In the process of analysis, the data from the various sources was triangulated, showing overlaps and complementarities, thus ensuring that the findings could be considered to exist, rather than to be artifacts of some aspect of data collection. The findings are linked back to the

research question. Importantly, the findings are also positioned against the existing literature of the field, with the similarities and differences discussed.

The criterion of dependability is a challenging one in the context of ethnography. It demands that the information provided, in the Methodology chapter in particular, is adequate enough for another researcher to follow in setting up a similar study. The practice theoretical approach places an emphasis on the importance of site and descriptions of an ethnographic approach reinforce the significance of the particular setting and the ethnographer's expertise in entering into the culture of the group being studied. I have tried to ensure dependability by setting out the general principles of ethnography and the data collection methods I used, giving the reasons behind my decisions and the main sources that influenced me in those decisions.

Confirmability has two aspects to it. The first is about the integrity of the data, as specified by Lincoln and Guba (1985, p. 318). All records have been stored in a taxonomical order as mandated by the approval given by the Human Research Ethics Committee (HREC) of the university. These include records of the recordings, transcriptions, pseudonyms dictionary for anonymization, consents, ethical approvals, training certificates for access, Dean of Science approval, Leader of the laboratory approval, field notes, data analysis, codifications, illustrations, academic papers, my research, and all notes from all the sources and bibliographic references I have used. All these sources of data have been stored and codified according to their pseudonyms and backed up periodically and with restricted access to maintain and guarantee confidentiality as agreed via the approval process mandated by HREC.

The second aspect is about the relationship between the data and the findings. In writing vignettes, I have used rich description, an integral part of the literary style of Marvellous Realism, following Geertz (1973). Also, in the conventional approach in qualitative research, I have used quotes from the observations and interviews and from my fieldnotes. I have not been able to use quotes from the media statements or the academic papers of the scientists because these

would certainly identify the laboratory and also, often, identify the individual scientist. This would have been in breach of the conditions of approval from HREC, and of the understanding of the scientists themselves.

The next criterion of transferability – that the findings can be transferred to a different context or group – also has its challenges. I do not claim that these findings can be transferred to any other research laboratory. However, in keeping with the requirements of ethnography, and given the significance of site in the practice theoretical approach, I have provided a detailed description of the context and setting of the research and using findings from other studies as a point of comparison with my own study. These processes show the extent to which the findings of previous studies are confirmed or extended (or even rejected) and demonstrate where there are aspects of the findings that are worth researching in other contexts, to investigate the extent to which the outcomes might be similar.

The final criterion of reflexivity, originally seen by Lincoln and Guba (1985) as a process for ensuring confirmability but later (Guba & Lincoln, 1994) acknowledged as a criterion in its own right, concerns the iterative process of engagement between the researcher and the setting of the research. The researcher acknowledges his own part in the research process. I have emphasised the dual position I adopted as ethnographer, as the social researcher on the one hand, and the engaged human being on the other hand, the person who recognised that he affected and was affected by what happened around him. While this is clearest in the writing of the findings, traces of reflexivity are found throughout the chapters.

Ethics Approval

Ethics approval is a further dimension of the quality of the research (Bryman, 2012, p.130). Approval was sought for this study as required by university and government regulations and was subsequently obtained: the approval number is UTS HREC REF NO. ETH17-1639. Seeking consent meant from the

beginning that the research would be overt, and that participants and other members of the laboratory could understand that the presence of the social researcher to perform the study was approved not only by the head of the laboratory, but also by the Human Research Ethics Committee of the university. This also implied that scientists could participate freely and without coercion. Anonymisation of those participating would also imply that the researcher would not only use pseudonyms for the participants but that the researcher would actively aim to remove any link that could associate the participants or the laboratory with the research in any way. One of those links that is crucial for them, and for this investigation, is the use of a concept that has not been traditionally used in the study of bacteria and that participants claim as an innovation, paramount for them as it informs their practice of observation and use of microscopy as a technology. I decided to replace the name of this concept, since even a basic online search could help identify the group. I have pseudonymised the concept and used the word “Echoform” (a made-up word), in order to replace the concept, protect the identity of the group and not sacrifice the flow of the narrative.

The anonymisation and use of pseudonyms helped participants to feel at liberty in expressing their opinions with freedom and to be more candid during our interactions. To this effect, participants had to sign a consent form (Appendix 2) and the option “Do not identify me” was the default option for this investigation. It is also important to note that within the commitments of the HREC approval are the protection of the data, that access is restricted and authenticated, and that data is maintained and backed up via various means. All the data pertaining to this research from design, field notes, interviews, transcripts, pseudonym dictionary, and so on are organised taxonomically in a secure location and backed up according to university requirements.

Therefore, in summary, all scientists participating in this research have been anonymised through the use of pseudonyms, which were chosen through the Scrivener application. The password-protected software has the ability to generate pseudonyms and keep the database against the original names. The

participants have signed consent forms before participating and all the data has been stored and safeguarded according to the university's requirements.

Conclusion

This chapter presented the methodological approach used in answering the research question. This approach derived from the theoretical underpinnings of the study, in a Schatzkian practice theoretical approach, a Latourian emphasis on the importance of non-human actors in the information practices of scientists, and Knorr-Cetina's notion of an epistemic culture. Having explored the reasons why ethnography is an appropriate methodology for the study, the chapter presented the social researcher as the first-hand witness of the social dynamics at the interior of the culture being studied, that of scientists in a university laboratory, with the focus on their information practices. Through this process I also explained the reflexive approach I took to my engagement with the scientists and their culture, and I touched on how I managed the interpretation of the findings and the challenges inherent in writing an ethnographic accounts, and the justification for using Van Maanen's (2011) approach and the value of using literary devices in writing the accounts.

The chapter described the methods for data collection through formal and informal interactions, setting out the various ways in which I gathered data. It also described the means to analyse such data, both using content analysis and my own approach, the Cosmic Zoom, as an analytical tool, to demonstrate the ways the scientists appear to be in contact with more than one domain during our interactions. In the final section, I showed how, at each stage in the study, I took steps to mitigate potential risks to its quality, and how I was mindful of the criteria through which the quality of an ethnographic enquiry is conventionally judged.

In the next chapter, I will present the findings that have emerged through the process the process of ethnography and data analysis. I will present the physical context or environment, the actors participating in this research and the

practices of the scientists the approach to ethnographic writing described in this chapter.

CHAPTER 4: FINDINGS

Introduction

This chapter presents the information practices of members of a scientific laboratory in a university in NSW. The study follows some of the members of this group of scientists while they were carrying out their investigations. The text presents the findings of this ethnographic study in two ways: firstly, taking a conventional descriptive approach to the findings and indicating each of the distinct information practices of the scientists in this laboratory, secondly, through a series of vignettes, which deepens the understanding of the information practices. In doing so, it draws on the approach of van Maanen's "realist" and "confessional" tales (2011), influenced by the storytelling and the "marvellous realist" approach of the Colombian novelist Gabriel García Márquez (Zamora & Faris, 1995).

The first section begins with an exploration of the context where the ethnographic study was performed. It describes science as a system of practice that informs aspects of the information practices of scientists. It next introduces the actors participating in this study, both human and non-human. The section ends with a description of the laboratory and the different areas, which were found to provide the conditions for different information practices.

The next section presents the information practices of the scientists. It is divided into three sub-sections; the first subsection presents the ways members of this group of scientists use information and create new knowledge in an empirical form. The next two subsections describe the information practices of scientists from a social and contextual perspective using vignettes. The vignettes describe the information practices of scientists not only cognitively, but include other perspectives, including the emotional and corporeal aspects of the information practices to elucidate the scope of these practices. This chapter establishes that the practices of these scientists draw on a more complex set of factors and

circumstances than is evident in their academic papers, and that these have an impact on and are, sometimes, influenced by other factors. The vignettes are grouped together and presented in two sub-sections. The first section focuses on the information practices of the scientists within the laboratory. The second section shows how external domains can have an influence on the scientists while in the laboratory and makes evident the everyday life practices of the scientists negotiating important aspects of their personal and professional life.

The last section presents the implementation of the ethnographic methodology from the perspective of the researcher. It discusses the social researcher's positionality as an ethnographer while becoming immersed into the laboratory and how that was expressed with a reflexive approach, evident in the ethnographic accounts.

In summary, the findings present a view of the information practices that underscores the complexity of an environment that emerges with a move away from a perspective bound by the limits of the site of observation, and that demonstrates the significance of other actors, human and non-human and other domains in their practices. Taken together, the findings and in particular the vignettes tell a story, a story that is particular to members of this laboratory, but that at the same time reflects the ways information practices emerge from alliances and relationships, where actors influence their environments, working across groups and networks to use, share and construct information.

Getting to Know the Context

This section, written in the third person, explores the context in which the social researcher immerses himself during the observation period, beginning by examining science as a system of practice that frames many of the activities performed by scientists. It then introduces the participants in the study, human and non-human, each of the scientists, and then the microscope and the bacteria, before it takes the reader into the biological laboratory as a physical and conceptual space that both constrains and influences the practices of the

scientists, providing each of its distinct areas with different moods and dynamics. This section, Entering the Biological Laboratory is written based on fieldnotes.

Science as System of Practice

The impact of science and the scientific community as a system of practices and expectations on how researchers do science, appeared on many occasions through conversations. Scientists in different stages of their career grapple with the implications of the reality that science and knowledge generation is not done in isolation, but with and for the community, which in turn dictates several practices, conventions, labels and a system of career progression, that they need to understand to practise science professionally.

The impact of the scientific community is strongly felt by all, from the scientific method, and its associated thinking, to career progression and the system of grants. The scientists in this study felt the pervasive effects of “Science” (not as a method or discipline, but as a system), in everything they do and from the first stages of planning a study and proposing a hypothesis, to the publication of a paper, the impact of “Science” and its effects on the ‘story’ were evident.

The effects of the scientific system on scientists and their practices are undeniable, from how it has an influence on the technology selected, or how the experiments are planned, to even the use of nomenclature and the use of concepts.

“[O]ne of the main groups in the world that has been working on this field and they want to change it [the term global clones] to international clones.” (Reza)

At a personal level, the impact is felt on career progression and their individual investigations, science operates not only as an intellectual endeavour for the understanding of the world, but as a community, as a political and bureaucratic system to which these scientists and their information practices need to

conform, or to challenge pre-established dogmas on the understanding of phenomena such as bacteria. From this perspective, science is not something out there, an undefinable something in the ether in which information practices occur, but from conversations with scientists in this laboratory, science arises as an actor capable of affecting, contending, influencing and relating with scientists to mould their lives, investigations and being ever present in the laboratory and their lives. Leah, the research fellow, whose career was not yet solidly established, said:

“If you take away all the bullshit of publishing and grants, then science would be the best job in the world.” (Leah)

The Actors

The two following sections of the chapter introduce all of the actors, both human and non-human involved in the study. They begin with the six scientists who volunteered to take part in my study (the group had a total of nine scientists at the time of the social research). I then introduce the non-human actors that have an important role in their investigations.

The Key Human Informants

The Leader of the Laboratory

Professor Karen Lancaster is a very eminent and well-recognised microbiologist, and many of her contributions to science have been pivotal for the understanding of her field of study. The details of honours and awards she has received would instantly identify her, and therefore potentially uncover the identities of other members of the team. Thus, it must suffice to say that she has been credited with a number of contributions to knowledge and science and has been the force not only behind some of the advances achieved by the laboratory but has been a significant influence on the practices of less experienced scientists. She indicated her role was to focus on the “...big picture questions” but she also promotes and represents the laboratory and their

investigations around the world, which implies that she would be travelling to different laboratories, universities and conferences through a great portion of the year.

The first thing that strikes the researcher about Professor Karen is her calm demeanour, which was unexpected given the number of commitments and engagements she could have at any time.

She is an excellent communicator. One of the first things the researcher notices is her capacity to explain quite complex and technical ideas in simple terms by using metaphors and comparisons. She tells stories and this is obvious in her public speaking and interviews. For her the stories told about the bacteria need to be coherent with the data as they unveil a powerful agent. Her passion comes through in every comment, and she is able to maintain the tension of the story until the end, regardless of how many twists and turns she adds. Each telling builds from her calmness from the beginning, turning to excitement, joy, struggle, while keeping the single thread all along until the end. When one listens to her, one has the impression that she is not referring to something but to someone; the bacteria are not only the subject of her observations, but become the main character portrayed as a powerful social agent. Her approach to storytelling has influenced the members of the research group.

Senior Researcher 1

Silvia Viviano is one of the senior researchers in the laboratory. Originally from Italy, she has lived in Australia and worked with the university and in the laboratory for a number of years, performing a hybrid role working for the laboratory and the private sector as permanent research member of the laboratory. She stated repeatedly that she likes this sort of arrangement because she was part of the academic work but also was able to see firsthand how much of that research got translated into real results.

Silvia came across as kind and approachable, very interested in helping and answering questions; she demonstrated her knowledge and expertise eloquently, as somebody who could practise her trade with her eyes closed and therefore, she was very comfortable and precise when talking about the ins and outs of her investigation.

Silvia is a great conversationalist, and it was always a pleasure to talk to her. Through her warm and approachable demeanour, one can tell that she loves to explain an unpacked science to others, and even though her English proficiency is excellent and it would be hard to pin point her background, once she gets excited talking about the bacteria, those Italian mannerisms come through, highlighting and stressing her words and ideas with movements and gesticulation, which betrayed her phlegmatic movements and calm composure at beginning of a conversation.

When doing the experiments nevertheless, she was totally in control of herself with almost surgical precision, her level of engagement both mentally and physically in the space around her was absolute. She would speak aloud and explain as she progressed through the experimental process, so as to make sure I would understand what she was doing, but the methodical progression of these steps could be measured in millimetres. This approach to work at the bench was evident in her interactions with students.

She would focus on the task and calmly explain the steps while she carried on with the utmost attention on what she is doing. With the coat, the goggles and the level of interaction with different elements Silvia becomes the methodical and precise scientist.

Senior Researcher 2

Reza Hematti is a Senior Researcher and an academic at the university, the only member of the team to explain his position in that way. He specialises in

[details removed for anonymisation], and his research has also focussed on bioinformatics. He works extensively with all type of bacteria but has great experience with one particular bacterium. Dr. Reza describes his role as 75% research and 25% teaching.

At the time of this study, Dr. Reza was involved mainly in bioinformatics, and even though he worked frequently in the laboratory, the majority of his work during the time of this study was in the desk area. Here, he explained, he would examine the genetic information of the bacteria. In the discussions with Dr. Reza, the genetic and information aspects of the bacteria were highlighted, and he constantly used the technical terms like integrons, transposons, genetic islands or novel insertions to explain his practices. This seems to be aligned with what is consider in biology the information “talk”, referring to the use of information concepts to discuss genetic processes (Jablonka, 2002, p.579; Brandt, 2005, p.629; Šustar, 2007, p.2; Osimani, 2014, p.897).

The most frequent technology he uses in his bioinformatics work has been the computer, software, and data sources (like databases) to evaluate or analyse the bacteria genetically. Dr. Reza is extremely technical, he appears to be reserved and serious, but he gets greatly excited when discussing his expertise and its implications. He said that it used to feel funny to be working in front of the computer most of the time rather than in the laboratory, because the traditional image of the microbiologist is located at the lab bench.

When interacting with Dr. Reza, one does not perceive the bacterium as a social agent as much as with other scientists, but rather as an informational entity, something that carries, copies and transcribes information.

Research Fellow

Leah Atkinson was, at the time of this study, a research fellow from <country of origin>. Leah indicated that she came to Australia as a research fellow supported by a major fund via a well-regarded university in her country of origin. She came to learn from Professor Karen and the group and to work on her

project. As a research fellow, Leah had some of the academic duties of a post-doc, such as assisting with the supervision of master's students, but no other administrative activities. She noted that "it's a bit of a different role from a traditional post-doctoral fellow". Leah was extraordinarily technical, and she would dive in in extreme detail about her information practices, the processes she enacted and the techniques she used.

She was straight forward and had no qualms about sharing her thoughts about the way she was feeling or what she thought about any subject, personal or scientific, about science or her situation. Her interactions were full of details that added colour and texture to her accounts. Her honesty and candour felt very refreshing, especially in the way she expressed her feelings, her love for science and knowledge and finding solutions, how she felt frustrated with system of grants and funding, "publish or perish" and how the circumstances could play against a scientist. Conversations with Leah were varied, they were personal, technical, reflexive and critical, she could go from a technical explanation to a personal anecdote in the same sentence.

She was a new mother and expecting her second baby. Her first maternity leave meant she had to reconsider the viability of her original project, since other groups had been working on the same area as her during the time she was away on leave. The demands of motherhood and science produced conflict for her. In our conversations, she pondered how many women have to postpone having a family until they could establish their careers, and how she was a rare case having children so early.

Post-Doctoral Fellow

Lucia Barbera is a post-doctoral fellow from overseas. Lucia has a PhD in microbiology and bacteriology; she specialises in microscopy and image analysis and would at the time oversee preparing samples of the bacteria and

observing the bacteria under the microscope. Lucia also supervised students and collaborated with researchers from other laboratories in joint investigations.

She was under contract with the laboratory at the time of the investigation, helping mainly with microscopy. She described her role as follows:

“So now, I actually just recently started a new contract, and it will be fully looking at the bacterial behaviour through microscopy. So, it would be a lot of observation on bacteria interactions and their behaviour in general.”
(Lucia)

As a post-doctoral fellow, Lucia would not conduct her own investigation, but she gained experience working on the laboratory investigations assigned by the leader of the laboratory:

“I guess it depends a bit on what your position as a researcher is, for example. Because I don't really have my own project, I work for <Karen>, so I will get different things to do.” (Lucia)

She also indicated and highlighted the difficulties of continuing her own research due to her visa status as a migrant:

“...Yeah, I have to apply for a grant because you need funds to continue your research, and also since I'm not a permanent resident or citizen, I can't apply to anything. So, I can't do it in the first place.” (Lucia)

Lucia is a very young researcher, very open, happy and easy going. Interacting with her was always exciting, she was always positive, and she genuinely seemed to love what she did. Observation was very important to her. She would explain with great bursts of emotion her excitement about her investigation and this excitement would appear both during the lab sessions and during interviews. She often focussed on her relationship with the microscope:

“... when you're in the lab, it [the microscope] is just like “Oh, yeah, just put this in this little thing on display. Trust me and you can actually see it happen!” (Lucia)

With her descriptions of the bacterial behaviour, one feels one is observing an anthropological culture of individuals, as if were:

“... So, this was a crazy crowded area. So, this is pretty cool. Let’s start and try to acquire some images.” (Lucia)

Research Associate

Nestor Romano is a research associate from overseas collaborating with the group during the time of this study. He is a conduit between the laboratory and an external clinic; one of his objectives is the development of methods for human biopsies using different techniques. Nestor was doing mainly experimentation and microscopy, but his major interest was on the development of techniques to identify a particular behaviour of the bacteria.

Nestor uses histology and microbiology to analyse tissue under the microscope. He typically works in all areas of the laboratory like the rest of the members of the group, but most of his time would be spent at the laboratory bench and in the microscopy area. He reports internally to Professor Karen and Silvia and externally to the clinic.

Personally, Nestor, a very young researcher, was very polite. He always showed himself eager to answer as many questions as possible. At first sight Nestor gave the impression of being serious or perhaps reserved, however, once he started to talk and interact, his demeanour changed. He was very informal when answering and when referring to his feelings and thoughts and very technical when describing procedures, which made all the interactions with Nestor very relaxed and interesting. He expressed himself with certain respect about the bacteria, always highlighting the fact bacteria are also beneficial to human beings.

The Non-Human Actors

I now introduce two non-human entities that had a prominent place due to their importance and relationships with the scientists.

The Bacteria

The bacteria are the main object of investigation in this laboratory. The main bacterium investigated by the laboratory is [name deleted to protect anonymity of the laboratory], but experiments may be performed with other types of bacteria to contrast and compare results and behaviours. These bacteria have certain characteristics that make them interesting subjects for research. The researchers in the laboratory attempt to understand the mechanisms by which the bacteria grow, multiply, and avoid antibiotic threats. Much of the work that scientists do in this laboratory, through experimenting and interacting with the bacteria, is to try to understand how bacteria live and thrive in different environments.

The bacteria arise during conversations with the scientists, observation sessions and throughout their public material, not only in reference to their bio-chemical or pathogenic characteristics. It is evident that the scientists tell a story, a narrative in which the bacteria are actively participating, involved in the laboratory drama and not set apart from it. In these stories, the bacteria emerge in anthropomorphic terms. The scientists refer to bacteria not only as an agglomeration of bio-chemical or genetic material, but as entities capable of behavioural attributes like cleverness, happiness, moral decision making and communitarian coordination, as it will be shown in vignettes like “Sitting at the Train Station – The Practice of Observation” and “Tales of a Microscopic Organism – The Social and Clever Bacteria”.

However, it would be a mistake to think that this communitarian way in which the bacteria reveal themselves is only part of the everyday casual talk of the scientists, an insider’s ‘way of speaking’, when in fact it is also something that comes through their academic papers as well. This relationship is not only an

intellectual one, based on deriving from a need to explain scientific observations, but is also an emotional one. One of the scientists indicated:

“I remember that observation ... Oh God! ... and having caught that moment, changed everything.” (Karen)

and another showed the closeness of her relationship to the bacteria when she talked in sensory terms about the bacteria:

“You may notice the smell of [the bacteria]. I think it smells lovely. Other people might disagree.” (Leah)

Despite of being a pathogenic and toxic bacterium, the scientists have a level of respect and desire to understand such an adversary.

“You need to understand [the bacteria] because they are part of us” (Nestor).

“Bacteria are very clever at acquiring resistance [...], so what we’re doing is understanding the way they behave so that we can treat them in different ways.” (Silvia)

Microscopes

There are several types of microscope used by members of the laboratory during their investigations. The particular selection of a microscope is based on the features and technology that will enable scientists to better observe their subject sample.

One specific example is the main microscope (microscope name anonymised), a microscope treated with the utmost care and respect by the members of the laboratory, due to how the technology enables the group to get closer to the bacteria and perform better observations.

“... It is only when we got the (microscope name anonymised) and the ability to do that... [it] was the ability to observe things with that sort of technologies that reveal what was actually going on.” (Karen)

The [microscope] lives in its own room and is a super-resolution microscope that does not have an eyepiece for scientists to observe. The sample is placed in a box, and images of the full sample are displayed on a monitor; this changes the rules of engagement between the observer and the device as the scientists themselves confirm:

“So, another very difficult and different thing of this microscope compared to the other ones is that as you saw, there's no eyepiece so you cannot see with your own eyes.” (Lucia)

Microscopes were revealed as prominent tools of investigation during the interactions with the scientists. It was clear from the beginning that observing the bacteria was crucial for researchers in this laboratory and that observation above other means of research had a paramount importance for the group.

“In [Karen]’s group, there’s always been a love for watching, which is why we are very big in microscopy.” (Silvia)

The role of the microscope is not only to magnify the subject. These instruments become crucial to investigating different aspects of the bacteria and their behaviour. They have different roles and specialisations, and contribute based on their utility, to the value or benefit they bring into the research.

“We couldn’t have made any of these observations without it, so microscopy is critical” (Karen).

This is when the microscope becomes more than a tool that mediates between the bacteria and the observer, its role, in general, is so crucial to enable observation, and its inner working so complex, that scientists carrying out observations relate to these devices as if they were associates. In many cases the microscope is more than an intermediary, it becomes a mediator in the way

that Latour (2005) described, having a direct impact on the information presented to observers, who need to assemble and associate with the device, handling it with care. In some circumstances, the microscope sets up the rules of engagement. It can raise the profile of the research results when quoted in an academic paper, bring prestige to the laboratory and has agency not only on the scientists, but on the knowledge presented on academic papers as well.

Entering the Biological Laboratory

The social researcher studies a microbiology laboratory that investigates how a multi-resistant bacterium survives and thrives in different environments. For the social researcher entering the premises of the laboratory is both an exciting and daunting experience. It is daunting because entering somebody else's physical and social place of investigation supposes understanding a number of implicit rules with the fundamental knowledge that one might not belong and will have to focus to capture much of the core of what occurs that would be, otherwise, natural for a more experienced person.

This laboratory is classified as a Physical Containment risk level two (from a classification of four), according to AS/NZS 2243.3 (2010). This standard classifies Australian facilities that physically contain microorganisms, or any other agents, which could compromise general safety and could pose an inherent risk to the greater population. Therefore, in order to be granted access to the laboratory, the researcher had to go through a safety training program, as have all the scientists.

The training is designed to help those who will be entering such a facility to understand how to act in an environment that deals with potentially dangerous substances and organisms that could accidentally escape outside the laboratory. The dual efficacy of the information presented was stressed, as it works to protect the person in an environment that could potentially be

dangerous, and also to protect the laboratory from any detriment to its reputation, if an accident were to occur due to lack of awareness.

Access to this scientific environment as a social science researcher is conditional upon acceptance and awareness of how to behave safely. As a further safeguard access was always contingent on being accompanied by one of the scientists. It was clear that even though the researcher was granted access, this was on the basis of being an external observer, and this in turn highlights questions often posed about ethnographic research, regarding how close to the real behaviour the researcher's observations are, or to what extent what is observed has a performative deviation from normality, since participants feel observed.

The social researcher reflects that the laboratory is in a way the product of multiple constraints and influences, such as safety, science standards, physical, cultural and industry requirements that shape the spaces and imbued social areas with their own information practices. A particular by-product of these physical distribution and safety rules constraints is that in combination, they create unique settings in which information is handled in different ways.



Figure 1: Laboratory Floor Plan (source: Fieldnotes, 2018)

Now it is time for the tour of the laboratory. When entering the space, one notes that the place is separated from the world by a number of gates, or safeguards. Coming from the elevator one can see to the right an area behind double glass doors that give access to the social hub for the different groups, a common area where all members can have lunch, have coffee breaks, work on their computers or simply catch up. This area has a number of couches, tables or desks, a kitchen area, meeting rooms, stands with science magazines, computer rooms and some offices.

The relaxed atmosphere of the hub brings the scientists to a level of normality in the eyes of the researcher. Their relaxed attire, some in sneakers, and behaving in an everyday manner, relaxed the researcher as well. Much of the context and conversations that occur in the social area could be incidental to their normal life as regular individuals, they do also have conversations about their current research and other matters of science.

It seemed to the researcher that the social hub works as a kind of transition zone between the external and internal information practices of scientists, where some personal and professional matters are juxtaposed in a casual and incidental way with more professional and technical matters, and where those “water-cooler” conversations occurred. In one of the lunches the researcher was invited to, with some of the researchers from overseas, they discussed the uncertainty of the system for researchers on contracts, and the difficulty for them to plan into the future due to not knowing if they could get a permanent residence visa, extend their contracts, or if they would need to hastily move on at the end of the current contract (Fieldnotes, 29/08/2018). Therefore, what the researcher experienced, is that the conversations in this area are not completely technical or personal, but an amalgamation of both.

From the social area, and between the sofas and a computer lab there are two set of doors that are opened only via granted access. One of the doors gives access to the desk area with desks across its length, where the scientists have their workstations and where they process and work on the data collected in the

laboratory, access information systems and the literature gathered from the library and from other groups. In this area also is the office of the leader of the laboratory and some little meeting or quiet rooms. When one enters into this area, one sees the scientists working at their computers. The mood and energy of the room is quite different from the more relaxed and congenial atmosphere in the social area.

There is also, contiguous to this first set of doors, another set of double doors that give access to a long corridor. Entering into the corridor, one will have access to the laboratory and microscopy area on the left and the desk area on the right. There are several access doors on the left, some giving access to rooms with specialised devices. The main room is the laboratory, which is a big area with lab work benches, instrumentation, devices and refrigerators where some of the specimens are kept dormant. Walking down this corridor one can find rooms where the samples are cultivated to specific temperatures and passing these rooms, one finds the microscopy area, where there are small rooms for specialised microscopes. On that first introductory tour, the researcher visited different rooms, one with centrifuge machines, one with a variety of microscopes and machines, and the main room with workbenches, refrigerators for the specimens, various machines and instrumentation. There were other rooms, where samples are cultivated at specific temperatures, and at the end of the corridor, there is a section with multiple rooms each with a specialised range of microscopes, the last one being the [microscope reference anonymised], a microscope with a particular prominence at the time of this study because of its technology and use by several members of the group (Fieldnotes, 27/08/2018).

The lab area is where the scientists are seen manipulating and interacting with the samples and the bacteria, it is where they do experiments and observation. There the mood is different again, and the scientists' practices are more clearly embodied. The spaces are very noisy, and it is difficult to carry on any conversation, due to the laboratory's inherent noise level from devices and

refrigerators constantly working. The researcher's fieldnotes refer to the impact of the noise level.

“Sometimes conversation and the recording is challenging due to the inherent noise in the room due to the different devices.” (Nestor's observation session, Fieldnotes, 29/08/2018)

“Note: The lab is a very loud setting and there is a lot of noise, the first couple of minutes is only settling down into the station.” (Leah's observation session, Fieldnotes, 10/12/2018)

Any conversations in the laboratory are focussed on the experimentation. The researcher as observer makes a note that the way the scientists interact with their investigation and the information practices in each area have different connotations.

In the early visits to the laboratory, the researcher certainly feels like a newcomer, following the steps of the scientists trying not to be in their way but positioning himself well enough as to not lose any detail of their practices. A question comes to the mind of the researcher; how do the scientists bring any data they collect into their workstations? They have been quick to point out that only paper and pen is allowed in the laboratory. The researcher in his professional life is a specialist in implementing Information systems and technology in organisations, and the prohibition of laptops in the laboratory – he reflects as the observer – could be a hurdle to capturing information. This is at odds with the way of working he is used to, and he wonders how they transport their own observations to the desk/work area.

Here, the researcher reflects, he seems to have an advantage over the biologist. The social observer can at least use a recorder and capture much of what occurs in the laboratory, and the impressions of his participants. It is not the same for the scientists, who cannot directly ask the bacteria for their impressions, while the social scientist is witnessing the social drama unfolding as he observes (Knorr-Cetina, 1999). The advantage here is not the recording

device as the biologist is equipped, as seen in Figure 1, with a number of devices (Latour & Woolgar, 1986, p.51) to interact with the objects of their investigation, hoping to transform recreated and staged circumstances with the bacteria into meaningful data. The advantage here is that the social researcher is able to directly ask the scientists for their impressions, and they are able to express directly to the social researcher what is going on with them.

The Information Practices of Scientists

In this section of the findings, I present the information practices in two ways. Using an approach conventional in reporting findings in a thesis I briefly describe the key information practices identified in the process of analysis. Then I begin the presentation of the vignettes that situate the information practices in their context, firstly focussing on those where the scientist plays a central role and secondly setting out those where the scientist sits on the periphery of the actions of other social systems. The findings from this ethnographic study are based on interviews, observations, fieldnotes, public media resources, public interviews, their website information, academic papers gathered during the collection period.

Using Information and Creating Knowledge

Accessing Information Resources

The scientists spend time using the computer as a multi-faceted technology. Through it, they interact with information systems, search sequences through genetic databases and access library resources. The importance of the computer in the information practices of these scientists is explored in more detail in the vignette 'It all starts at your desk.'

Awareness of papers from other groups is important. However, there seems to be an assumption that mostly members of the group are aware of papers published by other groups in their field. Therefore, there are almost no examples of references to literature searching, although when this occurs it is

important. An example is the following statement, where Lucia was trying to work back from something she thought she observed, to see if any other group had published on it.

“So, I did some literature research and actually I found a paper that was – their hypothesis was what I maybe saw ... I was “oh cool! Maybe I am not crazy! maybe is something that is real!” (Lucia)

Undertaking training in Biosecurity is another example of accessing information resources deemed important for individuals. All members of the group must regularly update the training they have received on bio-security because the lab is deemed PC2. This is a more complex version of the training than I was required to undertake before I was allowed to enter the laboratory to begin data collection. As I explained in my fieldnotes:

“I took today the lab induction for Bioscience PC2 which means Physical Containment Risk 2, which means Moderate Limited. What this means is that this laboratory deals with organisms, or substances that could be a risk if they are released” (Fieldnotes, 27/08/2018, Laboratory Induction).

Reza, who works with bioinformatics, spends much more of his time using information systems than do the other members of the group, as he explains when he says that he currently spends no time at the bench (see the vignette ‘Reza’s story’ for more details). Much of his work involves the use of a tool known as BLAST: Basic Local Alignment Search Tool. He explains what the tool does and how to use it.

“... [it] is an algorithm, and [it] is a tool that GenBank offers ... [Reza is searching for it in his computer] ... this algorithm has been incorporated to a range of different tools. So, a lot of bioinformatics tools they use BLAST. So what BLAST is basically, you give it a reference sequence and you give it a query sequence and what it does, let’s imagine this is a sequence: A,T,G,C,G,C, and this is your reference, and you give it another sequence which is your query, let’s say this is

ATCGC, what it does it goes in BLAST algorithm and all of the mathematics and informatics behind it, it compares these two sequences, and it gives you this output sometimes ...but GenBank allows you, just to get the accession number, you don't have to have the sequence.” (Reza)

Shared information systems are important to the work of the group. It is expected that scientists in the group know how to use the shared drive and create new folders in an appropriate way. Silvia, who is mentoring a new honours student, explains how to use the shared drive to store his work:

“... make a new one [folder] ‘cause you don't have one here and call it <Name of student> 2018.” (Silvia)

Nestor acknowledges the importance of knowing how to use the shared drive to store his data, and the value of this approach:

“When I start the experiment I create a folder –there – to save it and after we have finished, there is like a cloud store so we upload the stuff in there so I can see it from my computer. Because in the past, they were using USB where you can introduce virus and it's a big problem” (Nestor).

Personal Information Management

Although the shared drive, accessed from a scientist's computer is crucial to the work of the team, computers are not allowed in the laboratory area, and so it is up to each individual to make their own decisions on how to take information, often as memory prompts, from the laboratory and their observations there to the desk area where their computer is located.

These information practices highlight the translation and recording of observations into a more durable and mobile documental entities, electronic or physical, to solidify observations into pieces of information that can be moved

from the laboratory to the desk area for further work and analysis, electronically via the networked equipment or physically with notes on paper.

Leah describes at length how she uses a scheme of colour coding to manage her samples and their associated data. I observed her in the laboratory “making towers per colour code.” (Fieldnotes, 28/05/2020, Observation Session). She explained:

“So, I'll keep that key [colour code] and I'll use that key throughout. But in four weeks' time, I may use the same colours for different things. So that's why it's important to write up my lab book once I've done the experiments, because I believe that paper is never gonna last forever, and then you get confused as to where things were... I'll measure the zones and again write them on a paper, go back to my computer and then you take it all into an Excel file to calculate the area of the circle, and then I transfer all the data from Excel onto Prism which is a graphing program we use because you can make really nice graph.” (Leah)

Another aspect of personal information management is in the diary management that records when a scientist expects to be in the laboratory, conducting experiments and working with the microscope. Leah positions her diary management from a personal perspective:

“So, I have a little sheet that I do usually every Friday. It's just a little sheet. It's got ... Sunday Monday Tuesday Wednesday Thursday Friday Saturday and it's just a black box and I put a little scribble down on one side and I put on all my extracurricular activities or non-lab-based activities [as well].” (Leah)

Lucia, on the other hand, sees the recording of her plans to use particular equipment as making a booking. She says:

“Like for the period, it really was having a timetable for [the equipment], we give an example of what time we do things, [and what we want to do].” (Lucia)

Sharing Information

Sharing information emerged as a fundamental information practice for this group. Although there were examples of traditional information sharing, mostly information sharing was positioned in the context of developing or sustaining collaboration. An example of sharing information comes from the fieldnotes to the first laboratory meeting I attended, where I noted that Silvia was giving an update to the larger group on her investigation, although here, too, other group members indicate that they are considering ways to work with Silvia's ideas.

“During her [Silvia's] presentation, mainly Karen and also [another non-participant scientist XXX] gave ideas and questions, some of which Silvia wrote down for further development ... So, they collaborated on ways or another couple of avenues where they could test Silvia's ideas”
(Fieldnotes, 07/08/2018, Observation Session, group's meeting).

Some information sharing can be seen as part of the work of the laboratory. Karen emphasised the importance of cross-disciplinary collaborations in making significant advances:

“I wouldn't be able to answer any of these questions without the great collaborations I have from people from other disciplines and it is an interesting challenge to be a Biologist who doesn't really understand the mathematical model talking to a physics person who doesn't have any clue about biology, trying to find that language, a common ground understanding that we know that we are still talking about the same thing, there were challenges in that shall we say!!” (Karen)

Finding common ground from which to share information sometimes seemed daunting. Lucia remarked:

“Now there is another guy coming and I have to look at bacteria on a dragonfly wing, and it sounds like “Oh my god, how am I gonna do that?”” (Lucia)

Nestor, a more junior member of the team, began to explain how he was involved in information sharing, recognising as he spoke that it had been one of the more senior scientists who had actually sent him to meet members of another group:

“the microscope director, sent me and Lucia to speak with another group because that group is doing something amazing. Ok, so they sent us.”

(Nestor)

Attendance at conferences was another way information was shared. Following on from his description of being sent to meet another group, Nestor continued by saying:

“You go to a conference, you see people that do your job, you show them your idea, you show them yourself ... so, they can build the collaboration, and this sometimes is collaboration between universities or if you are lucky [with] a company.” (Nestor)

Karen, with her greater experience, expresses the same approach to information sharing, going to conferences to talk about the project, but describing quite a different approach when she said:

“I was sitting there, over a beer at the end of this conference, and she is like... ‘I think I can help you’...”

Working with non-humans

Collaboration and sharing information are not phenomena that are limited to human members of the group, but they are evident in the way the scientists interact with the microscope. The group’s website identifies the centrality of microscopy to their work. The microscope is introduced in the subsection Non-Human Actors and the vignette, Entering the special room and meeting the microscope, elaborates on the relationships the scientists have with it. That the scientists arrive at a point where the microscope as a tool becomes the microscope as collaborator can be seen in Silvia’s observation that eventually

she developed trust in the microscope to present her with the data that the microscope had gathered.

“...The convolution microscope that doesn’t have the eyepiece ([the microscope name]), she felt powerless the first time she used it and blind because she couldn’t find the samples, “you need to eventually trust this machine” she said.” (Fieldnotes, 31/08/2018, Interview Session, Silvia).

The bacteria, similarly, are presented as more than an object of study, the focus of observation. The scientists engage in a form of collaboration with the bacteria, the nature of which is expressed from Leah’s point of view as: “the bacteria “run the show”” (Fieldnotes, 25/06/2019). This collaborative relationship and the associated information practices are the focus of the vignette *The Clever Bacteria*.

Observation

The scientists in this study highlighted observation as the most critical and important practice within their investigations. As explained in the Literature Review, in chapter 2, the group leader has been very influenced by the work of van Leeuwenhoek, and this has in turn influenced the practices of these scientists, as the vignette, *Sitting at the Train Station*, shows.

Silvia introduced the significance of observation, seeing things happen in experimentation, when she said.

“We believe that seeing things happening is crucial in understanding phenotype.” (Silvia)

Karen, the group leader had earlier told me:

“...so, the seeing is believing, it’s far more powerful, and there are many times that I’ve been able to challenge dogma because, the dogma doesn’t make sense when you actually see what’s going on.” (Karen)

While observation is an information practice that is easily understandable to the layperson, I realised that for these scientists, it is a practice based on tacit knowledge. Nestor was working with the microscope. My fieldnotes record the following:

“He [Nestor] also had a sample of a rat colon in the microscopy, that he allowed me to look through. The experience was incredible, it was a section of the rat’s colon, and the shape was similar to an asterisk, with crevasses and purple dots, in the inner part of the shape there was a tenuous blue line, and he pointed out that that was what he was interested in. – My first thoughts were of amazement, to think that a simple blue line would be of significance, and I wondered how that would be important for him” (Fieldnotes, 29/08/2018, Observation Session, Nestor).

Observation is not just about looking through the microscope in the way that Karen’s statement would suggest:

“It’s all about LOOKING DOWN THE MICROSCOPE AND OBSERVING”
(Karen) (Emphasis in her speech pattern).

Both Lucia and Silvia explained that from their perspective that the process of observation is preceded by planning and preparation. Lucia remarked “It’s very labour-intensive ...”.

Silvia notes:

“When you go to a microscope, it’s done, pretty much done and you just observe, and if you can capture something, it’s good. Otherwise, you go back and it’s the preparation work that is most of the challenge.” (Silvia)

Location affects Information Practices

The different locations within the laboratory are described in the vignette, Entering the Biological Laboratory. The period of ethnographic immersion in the

context of the laboratory demonstrated that each location within the laboratory gave rise to a different kind of information practice.

The laboratory, where experiments are carried out, affords a type of more corporeal and sensorial practices, where is possible to appreciate the scientists engaging all of their senses and their body during their experimentations at the bench or in the microscopy sessions.

The desk area is where scientists sit during the course of their investigations to engage in the more cognitive information practices. It is here that the computers are located.

“You come up with your hypothesis and then you sit at your desk, and you plan it.” (Leah)

“Generally, that's why with successful experiment, you need to spend some time designing your experiment, that's why they really sit down and think, “Okay, this is what I want to get, which is the best way to prepare my sample.” (Lucia)

The social area provides a space where scientists interact in a more relaxed and casual manner sharing information on many aspects of their life/work experience, as is noted in the following comment:

“During lunch I was able to engage with [name of a non-participant scientist] in personal conversations about kids and parenthood”
(Fieldnotes, 12/10/2018, Lunch in the social area)

Discourse as Information Practice

An aspect of the information practices of this group is their development of a particular form of language. Firstly, the analysis of the media statements, recorded interviews and broadcasts showed that most members of the laboratory are skilled in presenting complex scientific ideas in everyday language. They do this in several ways, with the most common being an

explanation using analogy and explanations using metaphor, and the third being the drawing of explanatory diagrams. An example of the use of analogy is from Silva, who says:

“... it’s like a probe, and then, it attaches to something and pulls the bug, and then it does that over and over again, and by doing all of that retraction, and extension, it allows the bacteria to move across the surface, and that’s called twitching motility.” (Silvia)

An interaction with Reza provides an example of drawing explanatory diagrams:

“The right thing is that bacteria plasmids ... [fieldnotes: he draws and shows examples as he explains] ... again if you imagine that’s a bacterial cell, that’s a cell, they always have the chromosome [fieldnotes: he keeps drawing while explaining] ... imagine this is the chromosome, a lot of bacteria have plasmids as well, so you can define bacterial plasmids as extra-chromosome.” (Reza)

Silvia uses a metaphor to try to explain how a particular transformation takes place.

“So, when those genes are expressed, then you have phenotype. So, in its information, if you wanna do a metaphor, it’s like verbalising information, or not verbalising information. So, ... so you have book A and book B, they have the same information, but book B gets read a lot, that information gets verbalised for now and something happens because of that, the other book has got the same information, but those words are not verbalised, so they’re not turning into something else.” (Silvia)

This group of scientists is known for its use of the language of everyday life and social interactions to describe their observations of the bacteria. This use of a socially oriented language derives from a conceptual framework that underpins their work and brings a social outlook to characterise their findings about bacteria from a social dimension, in addition to the expected biochemical

outlook. (I will discuss this in the vignette “Tales of a Microscopic Organism – The Social and Clever Bacteria” and I will make reference there to the invented word “Echoform”, in order to protect the identity of the laboratory, as required by the university’s Human Research Ethics Committee.) A statement from Karen provides an example of this socially informed language:

“I think that DNA acts like a little bit of a pantry out there, we’re getting hungry we’re springing to some of that, that’s what [Silvia] was looking at, how do they access that DNA and utilise it.” (Karen)

The use of informal, everyday language to describe interactions with the bacteria is explored more fully in the vignette, ‘The Clever Bacteria’. This localised discourse not only uses a social language, an informal everyday language, to explain the behaviour of the bacteria but also uses anthropomorphic language in referring to interactions with the bacteria and the microscopes.

Embodiment and Sensorial Practices

Scientists working in a laboratory and carrying out experiments are engaged in embodied information practices as they use the techniques they have learned, usually through processes of trial and error as honours students and as doctoral students. These practices are explicit, as my fieldnotes show:

“When she mixed the sample (which at this point I thought: wouldn’t this hurt the bacteria?) she grabbed little samples with the mixer (a blue stick with a little circle at the end of the stick) and placed a little bit in the middle of each of the prepared interstitial plates with the prepared conditions”. (Fieldnotes, Leah’s observation session, 11/10/2018)

Silvia, with the responsibility for the induction of honours students, refers to the tacit knowledge about the ways scientists use the space at the bench in the laboratory. She refers to the ability to work well in that given space as “common sense”:

“And it's amazing how many people don't have common sense and you're like “Why are you doing it that way? That's really strange.” (Silvia)

She also shows me how the bacteria express embodied information practices:

“this [sample]has produced pigments so that’s when it’s happy and growing really well and it’s green, so you know that it’s happy.” (Silvia)

Developing Papers for Publication

This information practice was important to all the scientists in this study, although each presented it differently. The complexity of the practice is explored in more detail in the vignette *Constructing the Story*, with its subtitle *Package or Perish*.

Silvia observed: “That the scientific task is one of hypothesis, testing and repetition... retest and re-evaluate the hypothesis and results” (Silvia’s interview session fieldnotes, 31/08/20108). Lucia presented a similar perspective when she explained:

“if you want to prove that an antibiotic is effective on [the bacteria], we can do different assays in the lab to prove the same result. So, this will generally be considered valid, once you proved using different techniques that you're always getting the same results in the end, then that is publishable. So, you can say, ‘Yes, I'm confident that this is happening and my hypothesis is true,’ or ‘My hypothesis is false’” (Lucia)

However, the fieldnotes for the interview with Lucia also record:

“One important aspect of her interview was about the building of a story and the support that the technology offers for that story to meet the desired standard” (Fieldnotes, 27/08/2019).

The notion that a scientific paper should tell a story is expressed by others, including Leah, who describes having “to rework the story on just the one bit” to develop a paper deemed strong enough to send for publication.

A comment from Silvia shows that Karen makes decisions on when a paper has reached the standard where it is ready to be submitted:

“her [i.e. Karen’s] eye is the one that decides when the paper is finished and when we can publish it.” (Silvia)

The group are aware that not all solid research leads to publishable papers. Fieldnotes record that while Leah was on maternity leave, “another team published results on the very thing she was investigating”. Nestor comments on the need to consider the impact of a published paper. For this, one needs to understand the status of the journal a paper will be submitted to, and the possible need for funding to pay for the necessary page charges when a paper is accepted for publication. He observes:

“There are ... websites where you can publish free things, but that's not gonna have any impact.” (Nestor)

Reporting the Information Practices of Scientists

This section brings together eight vignettes that deal with different aspects of the practices of the scientists, including observation, experimentation and abstraction. The vignettes are arranged according to the scientists’ processes in developing a scientific paper. An exception is the vignette “Deconstructing the Bacterium – Dr. Reza’s Story”, whose concern in our interviews was on bioinformatics and genetic information aspects of the bacteria (see his section “Senior Researcher 2”).

The Buffer Zone

This vignette highlights personal information practices, information sharing and movement, information organisation and training. It draws on fieldnotes.

For the observer, the laboratory is not a typical social environment, with the number of behavioural constraints imposed by regulations like AS/NZS 2243.3 and many others. The lab seems to the social researcher like a social microcosm in itself, with certain patterns of behaviour and moods that are circumscribed by physical zones and that give particular connotations to the information practices that are enacted on each sub-area.

In particular, the section of meeting rooms and the hall area between the desks area and the laboratory or experimentation area, is “The Buffer Zone”. This section is between these two main environments and serves as a clear demarcation between the two modes of investigation, the analytical and the experimental. The meeting rooms are the location where scientists reflect and discussed their work and how some of those observations and data will be translated and transported into the desk area for analysis. This is also where most interviews with the scientists were held. The buffer zone, thus, is a buffer zone in a practical sense, but it also serves as a good metaphor for the space between the scientists’ work in this laboratory and the broader scientific world of which they are a part.

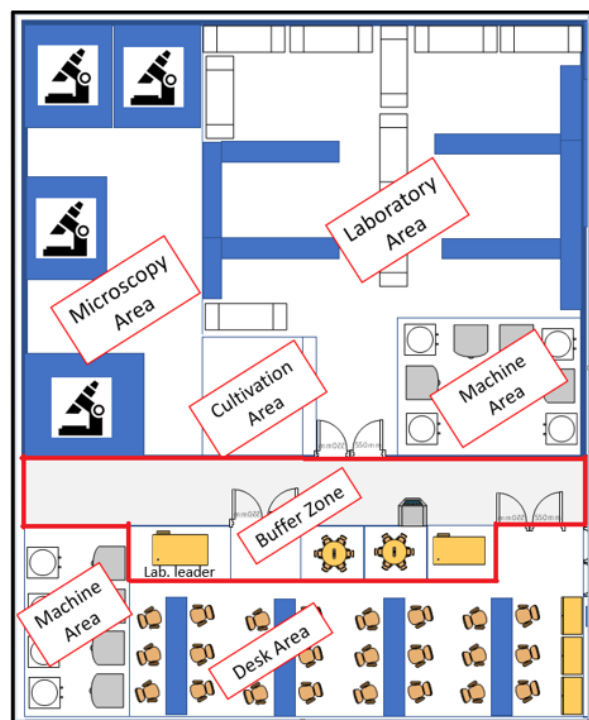


Figure 2: The Buffer Zone Detail (source: Fieldnotes, 2018)

The buffer zone is a clear delimitation between the laboratory or experimentation and observation area and the desk or analytical area, where most of the writing, planning and design decisions are carried out. Calling it a buffer zone highlights how those modes or changes in practices occur between the different environments.

The meeting rooms have clear glass walls through which the researcher was able to see the scientists interacting among themselves and working on their computers; researching or working with the data obtained during experimentation. It is important to remember that no devices like computers or tablets can be taken into the laboratory area for safety reasons.

This inability to bring laptops and tablets into the laboratory triggers an important question: which are the practices and strategies performed by scientists to bring the data from the lab and microscopy area to the desk area, where this information is going to be used to be analysed? The researcher observed these processes enacted in different ways depending on the section of the laboratory.

For instance, from the microscopy area, scientists used a mixture of personal and shared taxonomic structures, naming conventions and so on, to save data like images from the microscopy rooms into a shared file location to be opened from the desk. On the other hand, from the bench area, scientists used their own personal information strategies using pen and paper to bring data to the desk area, organising information and capturing results, as explained above under the heading Personal Information Management.

This extract exemplifies Leah using her own strategy to bring data from the bench to the desk area.

“I colour-code them because I don't want to have to write a really long description of everything [...]. So, we've got green has nothing in it, pink has tryptone, and I've got red for a compound called mucin, and blue for a compound called ESE.” (Leah)

On the other hand, the extract below shows Silvia instructing an honours student how to save the images in a central repository from the microscope room for later analysis.

“...So then now you create a folder for use ... Files, data folder and then this is the main directory, ... now you know you are in that main directory where the data get sorted, [...], so have a big folder and then all the little subfolder for each [observation] there.” (Silvia)

These paper-based records capture and freeze observations onto a piece of paper in categories that allow the scientist to encapsulate their results and observations into their own standards and to mobilise them, so they can bring them into the desk area for analysis.

Within the microscope area, scientists can save data acquired from their observations via the microscope’s computer into a centralised shared area that can be later accessed from their workstation. However, the way these observations are organised into these shared spaces seems to be a mix between personal and collective standards. Nothing seems to be mandated or enforced from an information strategy policy, but is, rather, informed and passed down through training, and each individual adapts and develops their own organic strategies and naming conventions through time.

Leah explains how she accesses the data from the central repository.

“In my electronic lab book, everyone is different, I have a folder that's called [folder name removed], which is the project that I work on and then I have it broken into twitch analysis and other experiments because twitch analysis makes up the bulk of it, and so with that twitch analysis, I'll have a file named [file name removed] because that's the project, underscore the date, and then the date is backwards, so it's 18-10-08, so that everything that's ordered chronologically by year and then by month and then by day.” (Leah)

Although there are individual ways of working, there is also a preferred way of working with the common file structure. Silvia, as a senior researcher, has the task of teaching a new trainee how to use the current folder structure and to keep the research data under a common structure.

“Student: ...Folder 2018. This one will be ...

Silvia: Today’s date.

Silvia: We have codes in our lab that you can see. It could be the experiment type that you’re doing.

Student: So just cells.

Silvia: Once you’ve taken all these images and you’ve got them on your computer in the same folder together with the notepad, then you remember, otherwise, every folder would be the same, and then you don’t know when you’re done unless you’ve very religious with your lab work.” (Silvia)

Thus, the buffer zone makes evident the separation between the desk area and the lab area, and it also serves as a metaphor of how the results of observations are transferred and translated from one area that is distinguished by the interaction with the bacteria to another area, whose main purpose is to analyse those interactions and data.

The changes between the different areas not only signify the change of physical spaces, but also the change in the information practices and modes of investigation, and these changes in practices are also highlighted by the changes in the clothing and accessories from one space to the next. When scientists are going into the laboratory area, they put on their white coats and goggles. Silvia emphasises the difference in practices between being in the desk area and being in the laboratory:

“Same as when you’re cooking, you’ve gotta prepare the space before you start doing anything because otherwise it becomes a mess ... It’s not

just sitting in front of your computer and writing something. It's being in the labs, and if you make your mistakes and you don't do anything right in the lab, you're never gonna find data that is good enough to write a paper.” (Silvia)

When scientists come back to the analytical area from the lab, they go through the buffer zone again and leave behind the observation and experimental accessories, clean themselves up, removing any potential chemical residues, and are ready to transition into the space in which they piece together their stories. Reflecting on their practices, the researcher observed that the transition is not only physical but is accompanied with changes in practices that surround how information is obtained, categorised, captured and transferred for analysis to the desk area, to at some point finally to be constructed into a story within academic papers.



Sitting at the Train Station – The Practice of Observation

This vignette highlights the core practice of observation.

“So we always looked at bacteria, we always stare at them, because you learn a lot by... looking ... even if you sit at a train station and you look at people doing something, you learn a lot about their behaviour, you learn about how they survive, how they find this or... but you have to look at them to understand that, and in our lab we have done a lot of microscopy to do that. You just watch them forever doing something and you might understand something by just looking at them doing whatever they normally do.” (Silvia)

This is how Silvia introduced the practices of observation, which are significant for the practices of the scientists in this laboratory. The first salient point, is how the researcher stresses the importance of observation and how this is in agreement with statements from the leader of the laboratory:

“...it’s all observational,” (Karen)

This seems to indicate that this group is attempting to see the bacteria’s behaviours, and this is confirmed by Silvia’s last sentence in which she insists:

“you might understand something by just looking at them doing whatever they normally do.” (Silvia)

This is an interesting point, but it might go unnoticed if one does not know, or is not aware, that much of the observation in micro-biology is aimed at reporting the physical, genetic, bio-informational, structural, mechanical and apparent morphology or chemical processes of the phenomena; the proteins involved in a particular Type IV Pili movement, or the eDNAse enzymes required to break down DNA, or the distance between particular amino acids, or the variations in a particular global strains genetic code, as I learned from the scientists or read in published papers and recorded in fieldnotes (Fieldnotes, 30/08/2018). However, what seems to be striking from the description above, is that it seems to imply that they want to “simply” observe what the bacteria are doing. Observation is a key information practice, especially in understanding or replicating behaviours, but it is not simple.

At first glance, this seems to be odd. To “simply” look at what the bacteria are doing does not seem to be that sophisticated compared with other processes apparent from the literature (Fieldnotes, 26/10/2018). However, what this statement encapsulates is a very intricate and complex way to perform observation and use microscopy within this laboratory, in order to provide an explanatory mechanism that does in fact require all the technical complexity other laboratories exhibit. The descriptive terms above were taken from some of the descriptions scientists gave of their competitors. This “simple” approach elevates the explanation from the apparent technical plane to the more abstract, social and behavioural.

One of the distinguishing characteristics of scientific work is the use of observation as a practice. However, the way this group of scientists uses and

talks about observation suggests that a particular form of the practice of observation acquires a great importance within this laboratory, as they themselves reflect when discussing observation, which is almost always coupled with microscopy. Karen emphasises that their practice of observation is different from that commonly used in their field.

“In modern times, people rarely used the microscope to look at bacteria, and they totally rely on certainly more removed things like sequencing, prodding, and molecular biology and so on, [...], but not really looking at what the bacteria are doing.” (Karen)

After interacting with this group of scientists, one gets the impression that not all observations are equal, or that observation as an epistemic practice could be performed differently in different environments. In particular, the members of this group of researchers saw the use of observation as crucial to their contributions to knowledge. Fieldnotes indicate (Fieldnotes, 31/08/2018) that during our conversations it was evident that observation and microscopy were both foundational for their approach to research, and that both the practice and the tool go hand in hand, to the point that it is difficult at times to make the distinction between the practice and the enabler which affords such a practice. This is because today's microscopy enables scientists to carry out the kind of observations that would be impossible without this technology.

The emphasis on observation and the use of microscopy soon stood out during the interactions with participants, when discussing their investigations. It was almost palpable that observation for them was more than another option within their toolkit. When narrating their investigations, the language they used went beyond transactional or merely descriptive accounts; their language in most cases became affectionate, personal, full of figures of speech and imaginative, which seems to indicate how important and personally engaged the researchers were with this practice-tool, or at least with the way they carry out this practice of observation as an epistemic strategy.

It has been evident when interacting with this group of scientists, that the way this practice is performed, is in great part due to the vision of the leader of the laboratory around observation and microscopy (see the section “Observation”). There seems to be an emphasis on understanding the bacterium’s actions, this seems to be foundational to the scientists’ practice of observation and trickles down to newer members of the laboratory:

“We are told to look at things, look at the bacteria, look at what’s going on.” (Lucia)

It is also expressed by senior researchers with years of experience working in the laboratory:

“there’s always been a love of watching, which is why we are very big in microscopy.” (Silvia)

In other words, it is not only that observation is central, which leads to microscopy as a practice, but that the end game that distinguishes how such a practice is implemented within the laboratory, is on understanding or learning how the bacteria “behave” rather than what it is. The practice of watching the behaviour of the bacteria is highlighted by all the scientists who took part in this study.

Its implications for the development of new scientific knowledge is explained by Karen.

“So, we were observing that behaviour and we were trying to understand the genes involved in that behaviour.” (Karen)



Entering the Special Room and Meeting the Microscope

This vignette introduces one of the key non-human actors. It presents the relationship between the scientists and the microscope, including the

importance of tacit knowledge to interpret cues given by the microscope. The vignette is based on field notes and on the recording of the observation.

This was the day, Lucia, an undergraduate student and I were walking along a corridor with a number of different rooms on each side, each with a microscope in it. The final room however was the [Microscope] room. Lucia was explaining the choice of microscopes for observation, in accordance with the scientist's goal. She said: "So, it depends on what we want to see, we do different things" (Lucia).

We finally reached the [Microscope] room and Lucia opened the door and announced: "The special room!"

And as we entered the room she added:

"Actually, we always show [this] – we like to tell everyone that we were the first facility with [this microscope], and this actually was the very first [one of its kind]!" (Lucia)

At this point, the centrality of the microscope was already evident. Numerous interactions with scientists had built up a sense of anticipation around the importance of this device for their investigations (Fieldnotes, 26/10/2018). Finally, it was time to meet this microscope, a microscope that has been critical in many of their contributions to knowledge. It was evident that the microscope had a great impact on the scientists and their research. As the leader of the laboratory had said earlier:

"... it's been a game changer. Without [this microscope] we wouldn't have made the observations" (Karen)

The theatricality of the door opening confirmed the impression I had regarding the special relationship between this microscope and the scientists in the group. The microscope was certainly an enabler, a tool to reach a greater level of detail and more precise view of the bacteria, but it could be perceived that the microscope was much more than this. As I interacted with scientists it felt at

times as if the microscope were another participant in their investigations, an actor in its own right (Fieldnotes, 30/08/2018).

The scientists' discourse indicated to me the criticality of the microscope in their observations, its importance, and a sort of dependency on the tool. They often used the phrase "...without it", indicating the participatory presence of the microscope as a tool; they emphasised its ability to empower them to see beyond their physical capacity.

"Being able to look at the cells at that level of detail it's being really quite amazing." (Karen)

I felt as if the local interaction with the microscope went beyond that of a mere important tool. The care, the anticipation, the special room, the planning and preparation of the sample for the observation stage, the ritual of turning on and setting up the device, and the intimate knowledge the operator needs to have in order to be able to interact with the microscope, all give the impression that the microscope sets the rules of engagement and that scientists are required to accommodate to the device (Fieldnotes, 30/08/2018). It was certainly treated with deference, and newcomers would not be able to work with it at the beginning: "No, we weren't allowed." (Lucia).

The role of the microscope was so important within the laboratory that it was clear the scientists were willing to accommodate how observation was performed and learn how to interact with it in order to access the microscope's capabilities and affordances:

"So, we need to increase either the exposure time or the power of the lasers. I will increase the exposure and try again. This is a very tricky sample because as you saw it loses focus very quickly, and this is again because of the movement of the gel pad. So, we need to be very patient." (Lucia)

The ability of the microscope to capture images with a greater degree of precision and present them in a sequence of consecutive frames so that the

scientists could observe the behaviour of the bacteria, implied that scientists were willing to engage with the microscope on its own terms, even if that was unsettling at the beginning (Fieldnotes, 29/04/2019).

“So, you have to search for your sample using the software.” (Lucia).

These new rules of engagement and this new performative relationship with the microscope did reconfigure how scientists interacted with the bacteria, rather than looking through an eyepiece and adjusting the focus, the scientist now travels through the sample with a joystick, as the microscope displays a representation of the sample on a computer screen. As Lucia remarked: “This [travelling through the sample] is quite tricky because there is a bit of delay between the joystick and the movement”.

Through the series of images, the bacteria are now presented in 3D and can be understood by the scientists as a community of organisms that could be observed as they were acting in real time, or close to it. With the microscope, the scientists could now observe a more active community while the microscope captures how the bacteria behave in response to triggers in their environment or under certain circumstances as set up by the scientist ahead of time. This intimate level of interaction with the microscope requires significant knowledge and skill in how to handle the different parameters of observation: the type of oil; the level of refraction; the cameras; the level of oxygen; the exposure (Fieldnotes, 29/08/2018). Those configurations also define the boundaries of their relationship, a threefold relationship between the scientist, the microscope, and the bacteria. This triple interaction makes me think that the three entities need to dance in synchrony to obtain the desired result as Pickering described.

“You have to be always very careful with the settings that you use [because you might damage the bacteria or cause the microscope’s readings to be faulty]” (Silvia)

Scientists were keen to explain to me the capacities of the microscope, and how they used these to achieve the outcome of the experiment (Fieldnotes, 29/04/2019). Having understood the authoritative position of the microscope for

this group of scientists, I undertook to develop a greater understanding of it, by reading published papers where its contribution is detailed, and by reading manuals about its specifications and use.

I can see the scientist carefully preparing the conditions to study the sample and all the preparation done up until that point in anticipation for the climactic point of observation. The scientist begins to calibrate the microscope in order to observe the sample under optimal conditions, the microscope and the bacteria of course set the boundaries of observation according to the specific scenario (Fieldnotes, 30/03/2019) If the scientist wants to witness a “happy population” she needs to work with both the microscope and the bacteria, because without that “you will definitely ruin your sample” (Lucia).

I watch (Observation session, Lucia, 30/08/2018) as the scientist navigates the constraints imposed by the microscope. She engages with the microscope in a conversation governed not by words but by technical parameters and images displayed on the monitor, and everything begins when Lucia, the scientist, enters the special room, taking me with her. She starts by turning on, letting the device warm up to keep the sample's temperature (usually 37 degrees); then, as the operator, she begins to engage with the device in a manner that is not only intellectual, but that is almost esoteric, reserved for the few with enough knowledge to enter into a relationship with the microscope. The scientist engages her senses, is aware of the physical space, the smell, the noise and its significance, I watch her as she responds, not just as a rational observer, but with emotion according to how things develop in this concerted effort to observe the sample.

“So, this part, again, see, they're both here and here. There's something inside that is happening What is that? [giggling].” (Lucia)

As in any other relationship, there are multiple aspects that are exercised during the course of the interaction, and in this interaction with the microscope that allows the scientists to witness the bacteria's behaviour, one of those aspects is

patience. Lucia appears to speak both to me and to the microscope when she says:

“So, we need to be very patient. I will increase the transmitters. ‘Cause I want to get the best signal to then have the best resolution because if we don’t get enough resolution, it would be very hard to actually see the membrane has disrupted.” (Lucia)

As operator and microscope engage in this dance in which the scientist tries to direct the device and the device sets the constraints through which the operator needs to navigate, they reach a state in which it seems that both entities, even if for an instant, become one observing entity, that separately would not achieve the observation but together will attain a new emerging state in which scientist and microscope act together to ‘see’ the bacteria (Fieldnotes, 30/03/2019).

As in any dance and relationship, an internal knowledge is developed, a synchrony of movements in which each partner seems to understand where the other is going; emotion is involved, patience is developed, and at some point, the scientist also needs trust, to let the microscope work on its own, to do its part.

“You need to trust that that machine eventually will find ... but it can be very frustrating. It takes a very long time.” (Silvia)

The scientists seem to direct, but only through the degrees of freedom allowed by the microscope, this new fusion between scientist and microscope. This assemblage between these two entities, with its symbiotic effects, becomes a ritualistic process in which the operator brings the device to the point of observation; they know it, not only technically and intellectually, but have learned to read the device, to read its actions and the particularities of its behaviour, even to the point of anthropomorphising the microscope, as female (Fieldnotes, 17/06/2018).

“So, the microscope will find our centre easier. She's trying to focus on the sample.” (Lucia)

But at times things do not work as expected, something might not be functioning normally, and it is necessary to troubleshoot until the problem is found. Here, still, the microscope may be seen in anthropomorphic terms. And, as in any other partnership, things need to be worked out, and things are not always resolved happily. Lucia explains that sometimes you have to backtrack, settings need to be reviewed, because the microscope is resisting the move forward and the scientist needs to understand how to bring the microscope back into synchrony with the direction the scientist needs to take. However, her intimate knowledge of the microscope gives her additional insight regarding where the problem might be:

“Generally, there are issues with the cameras [...] If you have a problem with the cameras, you have to manually restart the cameras.” (Lucia)

Now the sample is ready and placed inside the microscope; the microscope is ready to begin. This is a climactic stage, as mentioned by Silvia, Lucia and Nestor, and I can sense the anticipation in this session with Lucia, as this is also the final step of the experimentation process. Once at this point, everything that has occurred prior to going into the ‘special room’ has been done to make sure the observation is successful, all the work, the sample experimentation, the preparation, the planning, culminates in the special room:

“It’s a lot of work before. In fact, the microscope is the end part.” (Silvia)

Now, everything is ready for the observation, the scientist takes her place, takes the joystick and while keeping her eye on the many parameters, she begins to navigate the images presented on the surface of the monitor, to find one of the communities; on occasion, when some minutes have passed and there is no luck finding the sample, the scientist gives the microscope the opportunity of finding a signal that could represent one of the communities (Fieldnotes, 25/09/2018). At this point, the scientist releases control over the observations for a moment until the microscope comes back with a potential sample. Trust, as in any other relationship, is exercised here. I observed a reciprocal shift of

agency, with the scientist directing the process, the microscope searching for the sample. In what might be seen as a mantra, Silvia repeats:

“You can’t see, you gotta trust that machine is gonna find – and you have to – sometimes it can take 20 minutes to find a sample.” (Silvia)

Through this symbiotic process, I observed Silvia as she re-assessed and re-calibrated, confirmed the camera, the lasers, the parameters, fine-tuned the different variables, while the microscope displayed the images on the monitor, both machine and human assemble to accomplish the observation, a task that would be impossible in isolation. Trust is developed, as the microscope is in charge of finding the subject, and the scientist awaits patiently and works with what is presented to her (Fieldnotes, 25/09/2018).

During this observation process, each participant has her own role, the scientist seems to direct the process according to her goals, she has been working according to a preliminary hypothesis, through the planning and preparation, experimentation and she will obtain the data from the observation stage for further analysis. However, both the microscope and the bacteria are also part of the process, their presence is made known through the spaces in which they allow the scientists to manoeuvre; the scientist cannot simply raise the intensity of the laser arbitrarily, because it could kill the bacteria, and she cannot simply go outside the parameters allowed by the microscope. It requires that she knows and senses how her counterparts in the experiment are progressing, in order for each to successfully move through the contours of their own agency (Fieldnotes, 30/03/2019).

The scientist is the recipient of images processed by the microscope, the microscope not only magnifies, but also transforms the subject into a representation of the sample. This might be happening under the direction of the scientist, but within this space the microscope is able to work internally to transform the signals acquired into movies, 2D or 3D representations of the subject. This is one of the areas where the microscope might take the lead as it tries to find the subject within the sample. As a consequence of the whole

process, energy and explanation, my fieldnotes indicate (30/03/2019) that I begin to feel involved in the search for the community, understanding that it could be difficult to navigate the full sample and grasping, as an engineer, what Lucia is doing when she says she will use 'Ultimate Focus', a feature that will compensate shifts on axis and temperature to find a subject.

The microscope has a number of mathematical, computational processes and algorithms that allow it its own information practices: to convert signals into images, laser and structure illumination technology, wavelength excitation, algorithms like "Interference fringe pattern" and "Shear-warp algorithms" that use mathematical and computational processes to give volume to an image and present a 3D representation of an object. There are also the deconvolution techniques that performs mathematical inverse processing of images to obtain an image estimate with improved intensity. These are just a few of the many ways in which the microscope employs a number of processes, technological advances or techniques, which are black boxed into the device, to create a representation of the bacteria based on the scientist's input and which the scientist would not be able to achieve alone.

Observing the interactions between the scientist and the microscope I am intrigued that the role of the microscope is transformational (Fieldnotes, 30/03/2019). In other words, the microscope is not only passing the image along with a few degrees of magnification but actually applying transformation to bring a computer representation of the bacteria to the scientists, placing the observer as a witness of the bacteria's behaviour. This makes me reflect on the associative influence of the device in the practice of observation, as the device is bringing its own expertise to bear on the construction of knowledge. The microscope has become an important actor and influence on their investigations and is treated with respect.



Tales of a Microscopic Organism – The Social and Clever Bacteria

This vignette introduces the second non-human actor, the bacteria. It demonstrates the use of discursive information practices, using figurative language to reframe the position of non-human actors and their influence in the knowledge construction processes.

“I became really fascinated early on in my career ... as an undergraduate ... in how bacteria move across surfaces and how they organise their collective behaviour to do that, and we know that ability to do this group behaviours by bacteria is really important in their ability to spread infection” (Karen)

This comment comes from Karen’s description about her interest and the work of scientists in her laboratory. Through Karen’s intellectual leadership, scientists in this group see themselves as pioneers in the application of a concept that I will pseudonymise throughout this document as “Echoform” [actual concept name replaced], as a framework to interpret the actions of bacteria as coordinated and collective behaviour. The phrase encapsulates the idea of the bacteria’s agency expressed through non-technical language. This was apparent in the discourses the scientists used that constructed bacteria as a social agent (Fieldnotes, 26/07/2019).

“So, it's a community, like a group of bacteria that together they grow and do things” (Lucia)

This early interest also became, with time, the focus of Karen’s investigations. She was introduced to the concept of Echoform early in her career and adopted it as a conceptual framework that works as a foundation to configure participants’ practice around microscopy, observation and understanding of bacteria’s behaviour. Echoform provides a theoretical foundation, but it also provides the language to interpret observations from a social perspective and thus produces a picture of the bacteria as social agents. She applies this innovative concept to the work of the lab but also uses everyday examples to

explain by analogy to the social researcher, who is still new to the laboratory and the work of the scientists.

“... it also explains when you go for a hike in the bush you tend to follow the trail that somebody else made because is a lot easier, if you go for a drive you tend to stay on the road, even if it is a simple path. [This] is an example of Echoform.” (Karen)

Echoform, as an explanatory tool, fulfills a number of functions for this group of scientists, it provides a framework and an additional layer to the traditional biochemical perspectives, from which to interpret observations from a social perspective. In addition, it supports a meta-narrative that not only produces an explanatory mechanism, but also a social vocabulary, a language to describe a coordinated behaviour.

“So, my argument is that many things that bacteria do fall under this broader understanding of Echoform!” (Karen)

The information practices employed by this group of scientists, like microscopy and observation, are common practices in many biological laboratories. However, the way in which they are used, and the preparation of experiments has the objective of observing the bacteria's behaviour. This is an important local epistemic feature of this laboratory, that is in great measure sustained by having a common view and presumption that the bacteria have a behaviour that could be observable with today's technology. Such a presumption is theoretically founded on the conceptual framework of Echoform, which provides the ability to refer to bacteria by virtue of their communitarian behaviour.

“How do the bacteria talk to each other? [how do they] self-organise to do that.” (Karen)

The scientists describe how the bacteria function as a community:

“Somehow, they must be communicating that something is happening because otherwise you wouldn’t be having a community, if there is no communication there is not a community.” (Silvia)

This aspect of the bacteria may be surprising as the bacteria are usually presented in biochemical or morphological terms, but this additional layer of social understanding about the bacteria has been crucial for exploring other ways to think about them and how to counteract them in innovative ways.

“It is actually far more complex than that, and they do interact with each other, and they talk to each other through molecules that they share [...] The dogma for centuries was that bacteria don’t talk to each other ... I mean bacteria can’t think like we think, but is clearly beneficial for them to be able to do these communications” (Karen)

This language of community and communication highlight social aspects that are important for their investigation; by reclassifying the bacteria as a social agent they can establish parallels with human behaviour and translate their behaviour to a more familiar level of understanding and explanation.

That is chemical language, of course, it’s not the bacteria talk to each other but through molecules that they produce, they can sense and communicate between each other to say, “Okay, there is something happening, we have to behave in a different way” (Lucia)

However, and in addition to the social language, the scientists also use anthropomorphic language, providing the bacteria with human attributes, that portrait the bacteria, not only as a social agent, but as an important actor in the processes, as some examples below demonstrate. The participants referred to bacteria in terms that reclassify it as a formidable actor, and gives the impression that bacteria are not simply inert, but active in the process.

“I got a lot of respect for bacteria because ... they are very clever; they are much cleverer than us” (Silvia)

The researcher was told how bacteria have the ability to act intentionally with a survival goal, even though, at times the scientist recognised the implications of using a qualification for the bacteria that presupposes purpose, conscious activity, and premeditation, but again, the anthropomorphism seems fit to describe, at least at an explanatory level, a behavioural observation.

“They are deliberately doing this thing to avoid the effect of the antibiotic. We take away the antibiotic, and those cells would just revert back and be normal looking cells” (Karen)

The scientists also indicated that the bacteria demonstrate altruistic behaviour, in other words the ability of sacrificing themselves for their peers for the community’s benefit, another anthropomorphic reference.

“What we think is happening is that there is this sort of altruism in the bacteria, yeah, because this altruistic suicide pathway that gets turned on when the bacteria is undergoing so much stress ... So, it is sort of like altruistic suicide. We’ll die, we might as well be productive about it ...<laughter>... and help my siblings.” (Karen)

The anthropomorphic characteristics of the bacteria, sometimes, are pushed a step further when the scientists use anthropomorphism as a figure of speech, not only to ascribe human or social characteristics to the bacteria, but to give them human language and a voice as if the bacteria were reflecting on their own actions and could have a conscious reflexion on their own behaviour. The use of this figure of speech can be effective for explanatory purposes, as seen below, but also it builds on this social and communitarian light under which the bacteria is presented.

“What we call quorum sensing, is the language, if you want, the bacteria and especially biofilm uses to communicate with each other to say, ‘Oh, there is an enemy here. Let’s do something else to protect ourselves.’” (Lucia)

And also, the bacteria are seen as having the ability of making a cost/benefit analysis for survival purposes.

“So, keeping the plasmid has a cost to the bacteria because it takes energy to make it, but the bacteria weigh up the cost-benefit ratio and they say, ‘I’ll survive if I keep it because people are using Gentamicin.’”
(Leah)

And of course, the bacteria can also be smart:

“Bacteria are smarter than us and also their DNA is so small that they can change it” (Nestor)

This practice provides a foundation and a social explanation to their observations, portraying the bacteria as communitarian organism, and bringing forth opportunities to propose novel solutions to overcome the bacteria’s increased antibiotic resistance with new ways to counteract their virulence. This emergent social meta-narrative, that is brought to the forefront by their practice, is also made apparent through their informal talk, and explanatory analogies, and is evident in their academic writing.



What Happens on the Bench – A Sensorial Practice

This vignette presents embodiment as an information practice. It draws on fieldnotes, transcripts of interview and of observation sessions.

Entering into the laboratory area was a sensorial experience and prompted me to reflect on the different type of practices observed within this space. From this perspective, shadowing and observing the participants during the lab sessions and microscopy indicated to me as a researcher the nature of their embodied practices when moving and working in this space, where, by its nature risk is inherent, an environment full of warnings, practices and protocols to conduct oneself with care, awareness and according to them with “common sense”

within the laboratory space (Fieldnotes, 04/09/2018). For Silvia, the senior scientist in charge of students, post-docs and their experimentations, the reduction of mistakes is a skill that requires practice, but also a measure of this so called “common sense”.

“It's not just about the marks. It's not just about how intelligent they are, but it is about common sense and how practical they are in the lab 'cause at the end of the day, that's a big part of your job.” (Silvia)

“Common sense” then, is not the common sense of everyday life, but in this context is about knowing how to act in the lab, for scientists. It is a set of practical skills, embodied knowledge that is taught through modelling behaviour and mentoring of students (as seen in the vignette “The Buffer Zone”), pointing to the basic assumptions about how to act as a scientist in a physical space full of constraints. This ability of an individual to handle herself when working in the space is an ability fundamental to her professional career.

“It's crucial. It's absolutely crucial. We had one guy ... he had absolutely no common sense ... – he was great on computers, but he was a disaster in the lab.” (Silvia)

And of course, this common sense is paramount, because how scientists manage themselves within the laboratory could have a direct influence on how the experiments and the different techniques are performed within the lab, and a direct repercussion on their findings and the knowledge finally reported in their published work.

“It's not just sitting in front of your computer and writing something. It's being in the labs, and if you make your mistakes and you don't do everything right in the lab, you're never gonna find data that is good enough to now write a paper. ... You gotta be really precise, ... <Student1>, the first time he picked up that plate, he dropped it. And so, if you drop it, you might have disrupted all biofilm. So, it takes a while to get familiar with the equipment that you're using on your bench” (Silvia)

And the lack of precision could be costly, leading to expensive mistakes:

“And now I had a little issue while we do the inoculation so hopefully, I haven’t damaged everything because when I put the cover slip on top, there was – imagine that this is the slide, I put the cover slip, here there was the inoculation point and - I had a very nice bubble all around the inoculation point.” (Lucia)

This emphasis on the specific embodied tasks performed in the laboratory was evident in Leah’s description of her experimental practice.

“...and you put a bit of bacteria at the end of the toothpick and then you stab it through the agar so that it touches the bottom of the Petri dish ... You try and keep it upright so that you're going through the same hole every time and then I go down ten times, one, two, three, four, five, six, seven, eight, nine, ten. And that’s just to make sure – 'cause if we only stop at once. There's a chance the bacteria may not make it through the agar” (Leah)

This physical interaction with the different elements within the laboratory is not only evident on the bench, but also in the microscopy area, where scientists engage with the microscope to observe the bacteria.

“You can bring the joystick here with you, so you can check we have to be careful and stop a bit.” (Lucia)

The importance of this physical practice is not only because mistakes could be detrimental to the quality of the data, but also because the elements they interact with could be potentially dangerous.

“If you actually have quite nasty bacteria, it’s better to do it in the bio-safety booth ... because in that way, you don’t breathe, because there’ll always be aerosol produced.” (Lucia)

Interacting with the bacteria, the samples, the devices, doing the experimentation and the practical work in the lab, requires a precise

management of the scientist's body within the laboratory, an acquired skill perhaps that could be taught, but needs to be practised "...and after a while they become second nature." (Silvia)

The work may be physically demanding, requiring not only embodied knowledge, but the ability to repeat it multiple times:

"Physically it can be quite hard because you sometimes have to prepare a thousand [samples]." (Silvia)

Such intensity has to do with repetition of experiments, but also with the number of repetitive tasks that are required within the experiments, not only with your environment but with the sample.

"I've done 14 sets on Monday. So, there's a lot of writing if you have to write on every single plate." (Leah)

This is a striking feature for me as an observer, the different modes of investigation, the physical learning and skills that are required in a setting like the laboratory, as opposed to the desk area, where the levels of concentration on one's movements and the precision required are perhaps lesser (Fieldnotes, 27/05/2019). However, as with embodied information practices in other fields of practice, these procedures become second nature with time, and could be done without so much thought, as though the body learns and keeps a memory of how to move and perform the processes without having to have the same level of attention.

"And the beginning can be quite challenging, and it requires a little bit of practice. After you practice many, many times then you become familiar with the technique, and [I] can do it with my eyes closed now." (Silvia)

The constant and continuous experimentation and repetition allow scientists to engage their senses beyond touch, as already discussed, to include sight to smell. This intense relationship and interaction provide a superior degree of

insight into the observed phenomena, that for me would have gone unnoticed, if the scientists did not highlight it (Fieldnotes, 08/09/2018).

“you'll see that there's a circle where the bacteria grow and then you'll see there's a sort of zone – see it when you hold up to the light, there'll be a zone and that's the twitching zone.” (Leah)

This sensorial and physical association with the subject of study was fascinating. The reference to smell came as a surprise to me, not only for the reference to smell in itself, but for the way Leah expressed the relation of the smell with particular bacteria in such terms (Fieldnotes, 08/09/2018). This indicated to me not only a degree of embodied knowledge completely absent for myself, but a degree of personal relationship with the bacteria as an actor in the process she interacted with.

“You may get a whiff once you've been [standing] here for the minute. It's quite sweet. It smells about like grapes [...] E coli doesn't smell so nice. Clostridium definitely doesn't smell nice. I think [this bacterium] smells nice and it's such a pretty colour as well!” (Leah)

For the scientists, their body is a tool of investigation and inquiry if you want a window to access their environment, so that they engage in a bodily way with their subjects of study, learn from them, but also and importantly, feel affected by them in a way that can produce new insights.

Mimicking the Natural Order

This vignette shows how scientists bring together their scientific knowledge and their practical knowledge by recreating the in vivo ideal conditions in vitro. They emphasise the importance of preparatory work, planning and experimentation design and relate this back to their original hypothesis.

The group of scientists in this laboratory attempted to recreate elements of the natural *in vivo* world, in order to understand how bacteria will react under different triggers. Scientists described how this *in vitro* recreation involves establishing an environment similar to that in real life, modifying that environment in various ways, working within limits for the bacteria, and acknowledging the need to pay attention to the parameters of the microscope that makes observations possible (Fieldnotes, 23/08/2019).

“So, we recreate roughly what it looks like in vivo, ...so an interstitial biofilm particularly is one that we use because it recreates something like a [object’s name removed to preserve anonymity].” (Silvia)

Such a recreation of the natural order, in an environment where all variables tend to be controlled, is an effort in mimicking the necessary conditions to make the bacteria react in ways they would react within the natural conditions.

“So, that interstitial biofilm is mimicking the movement of the bugs and that’s the twitching motility that we studied...” (Silvia).

“The twitching is how they [move] along the [object’s name removed to preserve anonymity]. So that if you figure out how the twitching system works, you can then potentially figure out ways to stop the twitching. If you can stop the twitching, you can stop them being able to transpose down a [object’s name removed to preserve anonymity] or whatever.” (Leah)

Many of the practices of this group of scientists revolve around creating the delicate balance of conditions that can mimic the natural order, and which will be conducive to observation under the microscope. This is a painstaking and time-consuming process and can involve planning for many repetitions of the experiment; the repetitions can affect the practical outcomes of the research on the one hand, and on the other hand, they are a necessary part of the scholarly work of the scientist, as Leah explains:

“...and we do three replicates of each strain and each experiment just again for reproducibility, but when you publish, you should always have replicates within an experiment and then replicates of the experiment.”
(Leah)

Leah continued, explaining that this is the time for the detailed technical work. Her explanation demonstrates the implementation of the practical knowledge, the logistics of setting up an experiment:

“Do the strains need an antibiotic or not? And then you plan out: well, I need to do three replicates of three strains and three different medias. So that’s three times three, which is nine, times three, which is 27, so we need 27 plates in total. And then you work out what media you need. So, do I need nine plates of BSA media, nine plates of tryptone, and nine plates of no additive And then you plan – well, to make nine plates, I need 90 mils of media. But you always make a hundred ‘cause for some reason it never quite works out” (Leah).

The scientists were at pains to point out that this preparation is derived from the research design, what they want to test and therefore what they want to observe under the microscope, mimicking the natural order is a purposeful activity:

“...and if something goes wrong there, you’re gonna waste a week of experiments.” (Lucia)

It goes hand in hand with careful planning for observation once the conditions have been obtained on the bench. Lucia explained that the microscope also needs to be prepared so that it can observe the samples from the experiments. All of this requires significant practical knowledge, that needs to be called on at a moment’s notice:

“So, we first have to understand the fine scale, because we don’t even know if this is gonna be a very fast event, so in seconds or even milliseconds or minutes, we have no idea. So, we can set here a time-

lapse experiment where they acquire images even every second [for] which this microscope is good.” (Lucia).

At this point, I, as the social researcher understand that attempts have been made to replicate the natural order and the *in vitro* conditions created, the bacteria have been prepared, the microscope has been prepared, and as the observer, I should be prepared to engage in the “special room” in a delicate balance where these three actors, the scientist, the bacteria and the microscope) engage in the act of observation (Fieldnotes, 23/08/2019).

“When you go to a microscope, it's done, pretty much done and you just observe, and if you can capture something, it's good. Otherwise, you go back and it's the preparation work that is most of the challenge.” (Silvia)



Constructing the Story – From the Desk to “Publish or Perish”

This vignette explains how storytelling is used to share academic findings; how non-human agents affect the final story and how scientists navigate implicit rules to publish their findings.

“[it] all starts at your desk” (Silvia).

The scientists insisted that germinal ideas could come from different sources, a conversation, a paper, an assignment from the leader of the laboratory, but once a particular problem has been stated, the first stages of an experiment began at the desk (Fieldnotes, 19/11/2018). The design and the planning of experiments began with the scientist engaging with the literature and the potential experiments that could recreate an environment for the bacteria, under which the scientists hope they could capture behaviours that aligned with the hypothesis or original story.

“It's [Observation is] just the technique that allows you to see if what you're hypothesising is the right thing, but the majority of the work is all before.” (Silvia).

The desk is therefore a hub for making connections, where these scientists first start establishing the preliminary links with the literature to give shape to their experiment in order to test that original story. It is the personal and social hub of information for scientists where the research begins to take shape and experiments are planned. These scientists rely on their use of the computer (Fieldnotes, 10/12/2018).

“If I was to pick one piece of technology that I couldn't do without, it would be the computer, just because you use it for research, you use it for writing, use it for data analysis, use other programs on it” (Leah).

The desk, and specifically the workstation, the computer, became a technological tool that enabled these scientists to start delineating the hypothesis. It allowed them to start the planning, the conditions under which, as observers, they would engage with the bacteria. The computer, and perhaps in that sense more specifically the ability that the Internet provides to access different sources of information, made this technological tool the information storage, processor and information seeking device and the place from where the story that will become the scientific paper begins to take shape.

“One important aspect of her [Silvia's] interview was about the building of a story and the support that the technology offers for that story to meet the desired outcome.” (Silvia's interview fieldnotes, 27/08/2019).

This story will become a scientific paper, which is the principal output of scientific laboratories; scientists go through a rigorous process to present their results and analysis of data in writing pieces with the aim of contributing to knowledge. Therefore, publishing and publishing in good journals has a strong influence on how that final story is presented, and scientists learn those explicit

and tacit rules to help them to navigate the system and package their stories in the most effective manner.

“[...] it is not going to be good for me because my article is not in a good journal” (Nestor)

These scientists talk about the development of academic papers in terms of storytelling, switching easily from discussion of the hypothesis to the information practice of storytelling. The data they have contributes to reconceptualising the hypothesis and they replicate experiments reported by others, but they put the emphasis on storytelling, as is evident in the following statement:

“So, you have a hypothesis, you're gonna have an idea of what you want the story to be, [...] But that could be a fantasy world. So, you then have to do more experiments and then reassess at that point, “Well what is the story telling me?” You can't just come up with a story and then try and prove it. You have to beat the data and see what the story is – what it's telling you, what is that story?” (Leah).

This emphasis on storytelling and its consequence for innovative research appears in Professor Karen's reflexions on what she refers to as “the furrows story”, where observation and an open mind in the context of storytelling indicated a different way of interpreting what was seen:

“So, for example, the furrows story [...] I just sat there looking and looking and looking at these movies and kind of went ... what if... you know, it feels like they following a physical trail of some sort, ...and that was like one of those AH HA moments!” (Karen).

The final story in an academic paper is not only the result of the hypothesis, of scientists' intellectual postures and the scientific method, but in great measure, is also the result of the shaping effects objects within the investigation have on them during the course of the experiments. It is sometimes those very objects that could change the scientists understanding and transform their hypothesis into the final story presented in the academic paper.

“And then it turns out that the second protein that <other scientists> worked on wasn’t involved, even though Karen had had this previous data to show that it was involved. I don’t know what the guy did wrong, or I don’t know why our results said that... three different experiments [have shown] now that the second protein is not involved. ... So, that’s how the story has kind of changed, it’s good that there is still a story because it could easily have turned out there’s no paper at the end of it.” (Leah)

These information practices show that social norms and expectations have a moulding effect on how the findings are written up and presented to the audience. It also highlights that the information practice for these scientists is not only writing papers, but using the data tell a story.

“So, the data tell the story, but you’re also then constrained by the nature of publish or perish and that kind of tells a story.” (Leah)

The scientists acknowledged that there is great pressure for laboratories and academics to publish, because of the powerful reward system that exists in science (Fieldnotes, 26/07/2019).

“The way we are rewarded in science is to publish. ... You don’t get grants, funding, you don’t get promotions, everything is about this so-called: ‘publish or perish’.” (Karen)

The system of science also has influence on how such results are presented. Nestor, a scientist early in his career, was aware of this.

“Journals have too much power, pharmaceutical companies have too much power, government has too much power, so university research is sometimes tailored to address what is expected, rather than counterintuitive points [...] sometimes is better to play safe” (Nestor)

The audience, in this case the scientific community, to some extent, also has a shaping effect on what is presented in a paper. The audience may not determine the data or the outcome, but these scientists express the idea that

they know what is expected of the knowledge statement, or maybe which technology is used, so that aspects of the paper could be engaging or interesting to the community (Fieldnotes, 25/09/2018).

“There is a lot of push as well to use the expensive machinery that’s been purchased, so, if you know that your paper will be much, much better if you use that particular type of [microscope technology] for example, I know that probably it’ll make the paper much better, so, how can I fit that in? ... and in my case, I can, because I can just zoom in and have a look at the DNA.” (Silvia)

This vignette shows how scientists, more than producing academic papers, construct stories about the world. These stories are more than reports of observations following the scientific method, but they are shaped by the action of objects and pressures that scientists learn to navigate, as part of those implicit rules that shape their information practices.

Deconstructing the Bacterium – Dr. Reza’s Story

This vignette presents the search for and use of information in electronic resources; it also demonstrates a different discourse that frames the bacteria in terms of genetic information terms, that is “information talk”.

“This is the main reason why I’m really interested in this bacterium. So, the research I’ve been doing is mainly involved actually looking at the genomes of this bacterium, looking at ... how resistance has evolved, over time, how [they become] what we refer to as super bugs because they’re resistant to a range of antibiotics.” (Reza)

In this way, Reza described his work. Even though he was part of the research group and a participant in the group meetings, Reza seemed to be set apart

from the others, in the research topics he worked on and the information practices he performed.

“There are weeks that sometimes I don’t even step in the lab I just purely [do] bioinformatics and keep writing, and it’s been a dramatic shift and transition.” (Reza)

Reza carried himself with the dignity of a respected and experienced scientist, a man precise in his words, but eloquent when describing very technical and complex concepts (Fieldnotes, 07/09/2018). Many of his accounts were loaded with explanations that used information talk, in other words the use of information terms as a metaphorical tool, to explain bio-chemical processes at the genomic level. In this professional setting of the scientist’s workplace, Reza spoke only in the professional and structured jargon of the scientist doing his work; he did not bring in external factors. He came to life when explaining his investigations, creating diagrams and images with the computer or paper to illustrate whatever he was talking about, as explained in “Senior Researcher 2”.

“That unit can move and each of these units, so that green unit also can move, because this is also insertion sequence, this also another insertion sequence which can move, so these can move, this can move as a unit, this can move as a unit!” (Reza)

And as he says this, he is drawing and pointing at plasmids and insertion units on a piece of paper. He demonstrates visually, on a piece of paper, how the genetic makeup of a bacterium can also be understood through genetic information or “information talk” (cf Jablonka, 2002, p.579; Brandt, 2005, p.629; Šustar, 2007, p.2; Osimani, 2014, p.897), and how he can use these sequences to trace how certain clones move or diverge across multiple regions (Fieldnotes, 07/09/2018). As Reza has drawn out his explanations, he constantly engaged with me, the social researcher, inviting me to use my imagination to understand this complex scientific work.

“Imagine this guy has a plasmid and the second guy doesn’t have a plasmid.” (Reza)

But in asking me, the social researcher, to use my imagination, he did not use the metaphorical language of Echoform, as the other scientists had done. Instead, he used the physical and genetic characteristics of the bacteria when talking about them and drawing their interactions.

“[A]gain if you imagine that’s a bacterial cell, they always have the chromosome ... imagine this is the chromosome, ...” (Reza)

The focus on imagination to conceptualise the bacteria’s antibiotic resistance capacity is a level of abstraction different from this researcher’s experience with the rest of the group. Here, with Reza, the bacteria are not social, they are objects to be de-constructed, not only in their components but in the information value of the chains of proteins so as to try to identify the genomic make up of different strains that may have developed antibiotic resistance.

Reza’s tools for interacting with the bacteria’s genetic information were for the most part software tools as he explained (Fieldnotes, 01/03/2019), as described above in Senior Researcher 2. Reza’s interaction and his accounts were different from those of the rest of the group. The social layer that was so prominent in the other participants was almost non-existent in Reza’s accounts, as Reza’s information practices presented the bacteria in terms of its constituent parts. In spite of the differences in social interactions and the ways the bacteria were understood, the other scientists had the scientific knowledge and understanding to follow and engage with Reza’s work.



Living in Other Domains

The following vignettes illustrate how scientists connect to other domains where they also live and interact that may be external to the laboratory but that were relevant enough for them to include them in their accounts.

From Cup Cakes to the Bacteria Sample – Leah’s Story

This vignette displays how the everyday can be impinge on scientific practices, leading to a personal conflict in priorities. It uses data from the interviews and observations with Leah as well as fieldnotes.

The sterile environment of the laboratory, the instrumentation, the abundance of freezers to maintain the samples dormant, the multitude of signs and the constant sound of the machinery blending with the actions of the scientists, the clanking of the instruments, everyone in their white coats and safety glasses looking serious and performing their experiments. Not a silent environment, by any means, this laboratory; apparently an environment not really conducive to conversations, and certainly not a place where making icing for cupcakes would seem to be a topic for discussion (Fieldnotes, 10/03/2019).

As Leah explained the procedure for preparing her samples and performing her experiment, all of the sudden, there she was explaining and drawing together two very important areas of her life:

“So, you can see I just scraped the bacteria, so I get a nice little blob of it, ... and then I'm gonna squish it altogether, just mix, mix, mix, just like what I was doing with my wee girl after work yesterday. We made cupcakes, so I was just trying to get her to mix the icing which just ended up all over the floor, but it was still fun.” (Leah)

Perhaps it is Leah’s personality that led her to make this link between her practices as a scientist and her practices as a mother. Her story, as a new mother struggling to keep two very important areas in her life progressing in

parallel, motherhood and her practices as a scientific researcher, shows the difficulty of balancing the demands of these two identities. We see the scientific persona engaged in their scientific activity and practice, not only as an information processing brain, but with the whole of their persona coalescing all together, the personal, the emotional, the performative, in addition to the intellectual. The candour of Leah's accounts demonstrates these points clearly, the physicality of mixing the sample, the memory of her daughter, the struggle to keep such meaningful and important aspects of her identity alive, the decisions, the drama of personal experience. Together they show how information practices are not easily separated into those belonging to work or professional life and those belonging to everyday life, but in actuality, are intertwined (Fieldnotes, 10/03/2019).

She weighs the importance of family against her professional career, and the consequence of favouring one over the other.

"It was supposed to be two and a half years here, and a year and a half back to <my university> in the [country], but because I've had <my baby>, and then my husband's got a job out here, I can't go back to <my university> with <my baby> and leave [my husband] out here because we're a family." (Leah)

According to her, this difficulty of balancing family and career is one of the reasons why many scientists will postpone having a family until a later stage, when their career is more established, so they have flexibility to move around and focus their time and energy on their investigations (Fieldnotes, 29/03/2019). In fact, the expectation that scientists will move around is almost a deterrent to having children earlier, as Leah observes:

"Most people... – if you look at most people in academia-, they put it [having children] off 'til their mid-30s, just because you want to establish your career first." (Leah)

But what happens if someone, like Leah, wants to start having children earlier? She had settled on having children earlier, but she recognised the potential trade-off:

“I want a lot of kids, so I wasn’t gonna put it off for my career. If I do end my career in science, so be it. I’ll have some lovely kids. So, it’s a bit of a pain in the arse ... I’m not gonna put having kids off until I’m 40. Like I love science, but I love being a mum more, but it’s difficult.” (Leah)

This is anything but an easy decision, two potential areas of accomplishment and significance in the life of a person being in opposition to each other. Leah showed how she worked at maintaining these two important identities, expressing the conflicts as problems of timetabling, involving demands on her time.

We would like to “have our cake and eat it too” (Leah), but this would mean that at a minimum, resources like time and energy could be compromised, and they could affect how practices in both parts of her life are carried out. Therefore, she indicated, a way would need to be found in order to balance both the investigation and family commitments. One approach is time management, as we would expect that each area of influence will need to be given priority in the person’s agenda, as described below:

“So, if I was to try and squeeze another experiment in there, it may not work. Before I had [my baby], I would probably squeeze another experiment in, but now that I pick her up at certain time for day care, I can’t just work late. So, I’ve kind of changed the way I work a little bit. I don’t over plan things. I plan things a bit more realistically than I used to because I’m restricted to the hours that I work now” (Leah).

She is now limited in both time and energy because she is a mother as well as a scientist, this raises another potential conflict: she is aware that her personal situation puts her at a disadvantage with other groups researching in the same area:

“And then for me personally, I won’t work evenings and weekends now that I’ve got the kids. I don’t want to, but then I’m up against people that will work 80 hours a week, which – yeah, they’re putting in more work, but it means I’m not competitive.” (Leah)

Leah was candid enough to describe the predicament in which not only her brain or cognitive capacity, but also her physicality was compromised once she began her pregnancy; morning sickness was a significant factor for her to which she came back several times:

“Well, the physical side of it in terms of when you’re pregnant and you get really bad morning sickness, and you just can’t physically move. There’s nowhere to take into account any of that ... So, ... eight weeks where I could barely lift my head off the pillow and check my emails. [...], so that’s eight [weeks] plus, two months, where you’re not doing any work for this,

There’s a lot of things you can’t use in the lab when you’re pregnant and you’re also just a bit more weighted. You can’t stay on your feet for as long either. So, there’s all that – your productivity definitely goes down slightly when you’re pregnant.” (Leah)

Leah’s account seems to give testimony to her determination to become a mother; she knew in advance that her decision of having a family, would affect her ability to compete as a scientist and it made her reflect on the merits, or the feasibility, of doing both at the same time:

“Well, is it worth staying in a field where I either have to choose my family or my work? I don’t want to have to make that choice. So, it’s a bit stressful.” (Leah)

In part, this difficulty could be attached to the fact that the opportunity to make a mark on her career or establish her career could be dependent on those early years where scientists can travel freely and have more time to invest in their investigations. In other words, science is a competitive system, which focuses

on publishing and the ability of establishing a career could be the consequence of such academic papers. So, what happens when such ability to compete is all of a sudden compromised? Leah knew well that the demands of science and her decision of having children could have an impact on her own investigation and capacity to compete with other groups around the world and she expressed such a concern through her accounts (Fieldnotes, 10/03/2019).

In our conversation, this became clear when she said:

“I know ... there are three other groups in the world working on that project that my fellowship is on and I'm pregnant again, so I'll be finishing up in February.” (Leah)

After all the passion, the work and the interest, Leah starts to wonder if science is a viable career:

“So, in terms of staying in research or public engagement, I haven't really committed to either yet, but I'm doing a bit of both now, so that I've got the option to do either when I go back. So, who knows, see what jobs are available 'cause I want to go back to <my city in another country>.”
(Leah)

Negotiating Life and Science

This vignette displays everyday life practices like managing time to negotiate pressures and priorities from both personal and professional life.

It would be wrong to think that for scientists planning is only about the experimental and scientific work, as has already been shown in the section Personal Information Management. The confluence of areas and potential actors having influence on their agenda is nowhere clearer than in their diary planning, where scientists need to plan out not only their experiments, but how

they accommodate their experiments and other commitments in their life (Fieldnotes, 04/09/2018).

“So, I have to do a seminar at 12 today which I forgot, or I'll put ‘doctor's appointment at 3:30’, so that I know all my commitments that aren't lab stuff. And then I'll start planning my experiments.” (Lucia)

Time is one of those precious resources that could indicate the priorities in the life of a person. If scientists were only scientists and nothing else, only thinking about their research, planning would have a different focus, being centred on the research activity. However, planning and time management become crucial for these scientists in their everyday lives, as Leah's story has already demonstrated, and their time management reveals a number of relationships that require attention. Many of those other areas may be outside the laboratory but compete for their attention and require a slot in their agenda. Such commitments are not severed when they enter the laboratory (Fieldnotes, 15/04/2019).

“So, you need to plan out your week to know... well I can't start this experiment on a Thursday, because then I'll have to come in on Saturday.” (Leah)

So, they plan all their activities for the week to make sure experiments can be performed:

“[[I plan for] the whole week, because if you think, you're starting on Monday to prepare the media, glue the coverslip, make sure they're on the tubing, then you prepare the overnight, the day after you set up the whole system and you do the inoculation, you wait three days. On the third day, you detach the samples from there, you do other things to disrupt the biofilm without killing the cell and then you can do CFU [*Colony-Forming Unit*]. So that's a whole week, full week. And if something goes wrong there, you're gonna waste a week of experiments.” (Lucia)

The scientists intimated that the allocation of time to design, preparation and planning is crucial and a critical part of their work (see Sylvia's and Lucia's comments at the end of the section "Observation"). It is the groundwork, not only for experimentation, but also for observation under the microscope, to make sure an environment is created to generate the conditions for the observer to interact with the sample and obtain good data. Without the planning and recording of it in a diary, not only would the scientific work run the risk of not be effective, but other responsibilities, such as attending seminars and presentations, and essential tasks such as going to the doctor, would not be recognised as priorities.

Playing the Game – At the Mercy of the System

This vignette shows how scientists' information practices are impacted by everyday concerns and pressures from the larger system of science.

The social researcher's interactions with participants showed that these scientists do not perform their scientific practice in isolation from external influences, but they know that they have to play the game, whose rules are imposed by the system governing scientific research. They integrate their scientific activity with greater aspects of their career and lives. They described how they navigated science as a system, in order to try to advance their careers, and the demands that science could have on their private lives.

As Leah remarked:

“...So, it's kind of – you have to play the game...” (Leah).

All the scientists at some point let aspects of their personal life come through within the interviews or observation sessions, some more than others, but all of them would indicate, at some point, a certain area that affected them and that it was beyond their scientific investigation, even if only tangentially. For example,

they demonstrated a level of preoccupation and perhaps even anxiety on how to juggle their professional life and their personal aspirations, describing aspects of their life, such as career progression, immigration, job security, retirement, and some others of these, apparently, separate domains which affect their scientific practices (Fieldnotes, 30/08/2018).

Reza, for example, reflected on the need to take on a new area of knowledge in order to keep up to date:

“I was purely working in laboratory experiments [...] as the new popular sequencing in bioinformatics [developed], there was no getting away from it. You have to sit down and learn bioinformatics, and now gradually I shifted around 2013, 2014 as I was doing less and less lab work and doing more and more bioinformatics.” (Reza)

Their testimonies display Science as more than the scientific method and the pursuit of knowledge, but a system with its own constraints that are intertwined with personal desires and goals.

“So, I really like my PhD ... because it combines my background in pharmaceutical chemistry and microbiology and finds a midway to combine these two aspects as well. So, I got the chance to develop a nasal therapy using methenamine and nisin to treat the [bacteria] biofilm in the nose because biofilms of [bacteria] can be found in patients suffering chronic rhinosinusitis.” (Lucia)

The scientists need to figure out how to engage and play the game. For more junior scientists (post-doctoral fellows and research fellows) there is the expectation that they should move to different labs across the world. All the more junior scientists in this lab had met that expectation.

“There's also a culture of [where] you're expected to move countries in science [...] It's unusual to see people have a whole career in the same city, but again when you have families it's really difficult.” (Leah)

Such expectations come with their own challenges that can shape not only their future but also have an influential effect on their investigations and lives. Scientists from overseas working on contracts need to be aware of the conditions of their visa and the impact of any changes the government might make to the visa system.

“[A]nother problem is if you’re a foreigner in Australia, you need to have a contract of three years or more to even get permanent residency. And most of the contracts are one or two years. So, you can be out here for ten years on one-year contracts and never be able to apply for PR. [Permanent Residence].” (Leah)

The introductions to the scientists, earlier in this chapter, under the heading of “The Key Human Informants”, showed that several of them had come from overseas to work in this laboratory. As a consequence, they are in Australia on a visa, which is dependent on their employment. They are familiar with the uncertainty that provokes:

“So, there’s a girl in engineering department that we’re friends with and her contract finishes at the end of December, and she doesn’t have anything tied up yet to continue. But she’s on a visa, so if she doesn’t get anything in 90 days, then she has to get out of the country.” (Leah)

The thread of these narratives presents the accounts of scientists as they progress through their investigations and confront other factors in their everyday lives. In their stories, we can see the scientists in full command of their processes, manipulating the microscope or the samples during experimentation on the bench, explaining the informational, chemical, or biological content of their genetic material or proteins during their process of repetition to verify their results and findings. And then we see them confronting an issue over which they have little or no control (Fieldnotes, 30/08/2018), as Lucia expresses.

“Maybe tomorrow I have to pack my bag and go back to my country, you never know, now with the prime minister as well, who knows.” (Lucia)

Publishing scientific papers in good journals is an expected part of the game, as already presented in the vignette Constructing the Story and as emphasised by Karen:

“You could be a successful scientist, [but] you need to publish and publish... well there is a pressure to publish ...” (Karen)

The language of science in scientific papers can lead to disagreements. These scientists regularly communicate with non-scientists, as their media releases, media interviews and public lectures showed. The use of certain words in articles intended for the general public could also be a practice that could shape how the story is finally told when communicating aspects of science and their investigations, but it can bring criticism from other scientists.

“Some people have the school of thought that, if you call it ‘super bug’, you’re making it less realistic and more of a cartoony kind of idea and therefore people can’t take it seriously. But then the other school of thought is if you just use too much science jargon, people aren’t going to pay attention ...I think the more people you can reach, the better. So, I don’t mind the word ‘super bug’, but you get a lot of backlashes, a lot of comments on that article about people using the word ‘super bug’ but I don’t use it in [scientific papers]– well, I think I used it once in the article.” (Leah)

Part of navigating the system and knowing how to use the language of the scientific community concerned with the same area of research at times also implies being able to navigate scientific disagreements with other laboratories. Reza reflects on one such case, explaining how power or prestige can have a direct impact on how knowledge is categorised, and potentially on how knowledge and its terminology are used at the lab. He described the competing views between laboratories and groups.

“One of the really powerful groups in Europe has been pushing this term [International Clones] to change our term ‘Global Clones’.” (Reza)

To an outsider, this might seem a trivial matter, but Reza, an insider, provided other examples of the significance of choosing a particular word:

“...their paper was being rejected all the time because people didn’t like the sound of the term [term removed] and they were thinking that this is a stupid thing ... and everyone respects that now ... but the first time the scientist [name deleted] had to take the word off the title.” (Reza)

Sometimes there are established pre-conceptions within the discipline that are difficult to contradict, and scientists have to know when to challenge expectations.

“... When I was presenting that work early on people went just: “Nooo this is crap!” ... “we don’t believe that!” ... So, it took a little while for people to ... they obviously got it.” (Karen)

In the same way, the work published by other groups, their discoveries, their interpretations of their findings and their methodological approaches, are influential in the thinking of these scientists, particularly when another group is actively seen as a rival in what is a competitive field.

“I know that the group in [country deleted] did a lot of studies on this specific secretion system. They already published a few papers saying ‘This is what we believe is happening. We discovered this new type of secretion system in [bacteria] and we’re trying now to also visualise [it], to prove our hypothesis,’ because there are a lot of philosophical thoughts about the secretion systems and how they work and how they do things based on ... mathematical models as well.” (Lucia)

The scientists like to talk about their successes. However, they also can feel a sense of injustice about the practices of scientists in another laboratory, when they feel that others have not played the game, as the following account shows:

“We also had a terrible sad story happened here, because he published – he first discovered it, and he was the very first one utilising these things

with a particular technique as well, and then someone else working on a similar thing, published a paper disproving his theory, and then after a few months, the same group then published another paper saying that he was right without citing his work or even acknowledging or mentioning his research at all.” (Lucia).

For scientists, then, knowing the scientific method and having expertise does not seem to be enough. They also need to learn, understand and acknowledge other set of rules pertaining to the larger system of science, such as the expectation of moving across countries, how to navigate the system of grants, who is their competition, and how to manage potentially conflictual relationships. which could be important for them to learn how to navigate their careers and to have an opportunity at establishing themselves as scientists in the long run.



The Ethnographer’s Experience

This vignette focuses on the doctoral student’s journey to become a competent researcher. Drawing on the fieldnotes, it makes evident his dual role as researcher and participant. It presents his embodied immersion into the culture as he observes, exchanges information, and interacts with the scientists in their environment, and reflects on his responsibilities as narrator of the scientists’ information practices and their culture.

The sense of trepidation I felt being introduced to Professor Karen, the leader of the laboratory, to plead my case to do my research within her laboratory, was very strong. I remember I could feel my heart beating, as I sat waiting to meet her. I had read about this laboratory and although I had other potential sites, this was first on my list. I was curious about the metaphorical language they used

and the anthropomorphic reference to bacteria in their public material, and I wanted to understand how they would go about their investigations to build this frame of reference and construct new knowledge about this entity in particular. Thus, the memories of that afternoon are very vivid. I remember going to the meeting with one of my supervisors, who made the introductions. Entering the social area, I could hardly believe that this was real. Because of the aura scientists have in society, it was not easy not to feel nervous when pitching to do a social investigation to such an eminent scientist.

I remember sitting down on a couch facing the double doors that give access to the laboratory, when they opened automatically and she came through the doors, I recognised her from videos, I was nervous, and my heart was beating fast. It helped that she knew my supervisor, who had accompanied me. She sat with us, listened to me patiently and showed interest in my research. Throughout the meeting, she was relaxed and happy to help a social scientist, which dissipated a lot of my previous anxiety.

Through this research process, at times I felt like an outsider, overwhelmed by a sense of inadequacy, asking “What can I bring to the conversation?” with scientists who investigate a bacterium and who come up with clever solutions that could help humanity? I prepared myself thoroughly, so that I felt I would be able to talk with them. I read some of their papers prior to each interview, noted questions, highlighted interesting concepts to ask for clarity, watched and read their public material, expecting a rigorous scientist to explain to the technical detail of their investigation.

Indeed, they were rigorous scientists, who described the details of their scientific work with precision. However, they did this within the context of their lives. Hence, I also found human actors, emotionally, physically and socially engaging with their environment in a vibrant and lively way, rather than disassociated “brain computers” (Gleick, 2011; Pickering, 1995, p.182). I found struggle, and I could relate to that, I felt that I was making connections, talking about kids, how to make pasta, permanent residency or the news, simple things

but with implications as it allowed me to build rapport. These were the elements that cemented the interviews and observations, where I felt connected not only with the scientists as human beings, but also with the way they see the microscope and the bacteria and their role as participants in the study, and I could see myself as well, doing the same, interacting with my investigation not only propositionally, or cognitively, but also emotionally and physically; these were experiences that as narrator I have tried to convey

I enter the laboratory for first time with feelings of excitement and curiosity. This place of knowledge has required special training and approvals before access could be granted. I was admitted, albeit temporarily, to be part of this new world. I wore the white coat and goggles and looked like a scientist; I followed the ritualistic movements of my guides, washed my hands and I was attentive to the background noises emanating from the range of instruments and freezers where samples were maintained.

As a social researcher, I was eager to understand the information practices scientists enact for the construction of knowledge and scientific papers, but I was acutely aware that as an observer, I was part of the environment and that my presence could have an impact on the social dynamics I was witnessing.

This section of the findings is narrated with the voice of a witness; the style is descriptive. I write about myself in the third person, the researcher. The section draws on the fieldnotes as it captures the impressions of the scientists as well as the impressions of the researcher as he observes, interacts and travels with the participants across several 'Domains of Interaction'. From this perspective, the observer is not a disembodied witness, quite the contrary. This witnessing and the storytelling style, in the form of vignettes, makes a deeper acknowledgement that the researcher is not a hollow observer, but that he participates, affects, and is affected by the environment he is studying.

In this sense, the mention of 'Domains of Interaction', a concept introduced during the chapter on Methodology, specifically, under the section called "Cosmic Zoom as an Analytical Tool", might prompt the reader to wonder about

the need for such an expression as a technical term. The researcher assuming his analytical role uses the term to designate the plethora of domains, internal and external to the laboratory, across which the scientists move and interact, and which affect them in such a manner that occasionally they permeate their account. Through such accounts, the researcher embarks with scientists through both their personal and professional journeys, some of which were to be found outside the laboratory door. The researcher wanting to understand their scientific and information practices, analysed even those instances that might have felt far removed from their scientific practices and took them all as evidence of a complex information ecosystem where different layers of interaction could get translated and intersected during the scientist's practice.

This approach proved beneficial as it gave the researcher a twofold advantage. It allowed him to extend the information practices beyond the laboratory door, to illuminate a number of un-suspected agents and domains exerting influence on the information practices of scientists, but it also allowed him to calibrate the level of analysis from the macro to the micro by zooming in and out as he navigated with his participants across a number of Domains of Interaction. This zooming ability is the analytical tool the researcher used based on the analytical tool of the Cosmic Zoom, as described in the Methodology and Discussion chapters. Here in the findings, the researcher as narrator maps the ability of traversing through different frames or domains of interaction, beginning with the "home-frame" of the laboratory, where the scientists are observed during experimentation and observation at the centre of the process of information and agency, and then to lower and higher frames of magnification, where the participants also may interact but may also be at the receiving end of some of the domain's effects.

The researcher acknowledges that in the use of the Cosmic Zoom as an analytical tool, the reader might find a parallel between the scientists investigating the bacteria through the microscope and adjusting the zooming frame of the device, and the researcher as analyst using the concept of the Cosmic Zoom to adjust the frame of the social interaction and practices.

Perhaps in a way the social researcher possesses an advantage over the scientists whose practices he is investigating, as he is able to directly ask the participants for their impressions during the researching process, helping him to calibrate the level of analysis.

In presenting the researcher as narrator here, it is important to acknowledge that the narrator is not an all-knowing observer of the phenomena, as if he could watch from the outside with no intervention. I do not always present him as a third person narrator as Latour and Woolgar (1986) do. Quite the contrary, the social researcher is admitted into the laboratory after a series of pre-requisites have been fulfilled and for a period of time (intermittently between August 2018 and July 2019) he interacts with the scientists' social context (Geertz, 1973; Clifford & Marcus, 1986). On occasion, he tends to feel like an outsider. However, as engagement with the scientists progresses, connections are established, and some seem to develop more naturally than others. He needs to be aware of these social links; conceivably there were connections based on being of a similar age, and coming from a similar cultural context, such as being immigrant, trying to do research while working full-time, the shared understanding of the immigration process, being a PhD student, having a very close first language and other cultural connotations. It is possible that such commonalities helped to form communication channels that enabled a relationship to solidify more quickly and more naturally than it might have done otherwise.

The social researcher participates temporally and spatially in the social environment; he is seen within the laboratory and interacts with the scientists, and at times with other members of the laboratory. Ultimately, he affects and is affected by his own investigation, what he sees (Behar, 1996), the conceptual frameworks through which he is analysing the information gathered, his conversations, the papers and material read from the laboratory.

While the social researcher interacts with the social context, he establishes meaningful connections that bring forth information of value to his study. Thus,

the researcher effectively becomes an actor within the social context he is investigating. This much is undeniable (Van Maanen, 2011, p.76), and if he is an actor, it is necessary to understand the context and the nature of his relationships with the context and actors within it. This also becomes important because his level of intimacy with the context could determine the voices, he uses to describe his observations and interpretations, sometimes switching from the first to the third person voice depending on the level of familiarity with the events affecting him and his research.

The view of the social researcher as an actor imbued in the context is in keeping with ethnography, in that ethnography requires social interaction. The social researcher does not observe through a one-way mirror, but from inside and from the midst of practice, and this presupposes that actors are required to engage among themselves and with their environment to construct information and knowledge. The social researcher is building knowledge through the social interactions that he develops with participants, consequently, introducing the social researcher as an actor becomes an important aspect of this study.

Conclusion

This chapter has presented an answer to the question, **What are the information practices of a group of scientists working in a university laboratory?** In presenting the findings, it drew on the range of data collected in this ethnographic study. The chapter revealed the practices of these scientists in their context. It began by setting out the context of the scientists, acknowledging the system of science within which research scientists, like them, work; it introduced each of them as key informants to the study, and described the physical setting of the laboratory. To draw attention to the information practices, those practices observed were presented in two ways, firstly describing empirically the information practices enacted by this group of scientists and secondly, in a series of vignettes that embedded the scientists' information practices in the social context. The final section of this chapter presented my experiences as I developed from a doctoral student to a researcher learning

what it means to be an ethnographer, first through observation and secondly through the communication of those observations.

The next chapter, Discussion, situates these findings in the context of previous studies. It explores how the findings have contributed to knowledge about the information practices of laboratory-based scientists. It presents as an innovation the analytical tool, Cosmic Zoom, and sets out the concept called Domains of Interaction, that emerges from the use of this tool. It explores the methodological innovations in the writing of the ethnographic accounts. It ends with a discussion of my practices as an ethnographer, highlighting the importance of acknowledging the two positions the ethnographer must take.

CHAPTER 5: DISCUSSION

Introduction

This study has contributed to the literature of information practices, in particular with its focus on the information practices of scientists. This chapter will begin by examining the contributions of this investigation to Information Practices, at an empirical level. Having described these contributions, I then continue by presenting two sections that discuss innovations this study brings to research in information practices. The first of these considers the implications of the use of a form of Cosmic Zoom as an analytical tool. The second of these sections is concerned with innovations in writing ethnography, in particular, the importance of observation and approaches to reporting these observations, and the use of a literary style to write the ethnographic accounts. The chapter concludes with a consideration of the role of the ethnographer and its contributions to this study, a reflexion on how the practices that these scientists engage in as they observe the bacteria, and later as they reflect on their observations and write up the “story”, are very similar to my own practices in carrying out this study.

Contributions to Information Practices Research

This study adds to the small body of research on the information practices of a professional or work-based group, that of scientists working in a laboratory (see for example, Jones, 2005; Huvila & Gorichanaz, 2025). Peerbaye and Vinck note that there has been very little laboratory-based research to follow the seminal studies of Latour and Woolgar (1986) and Knorr-Cetina (1999). They reflect on the reasons for this, identifying the difficulties of gaining access to laboratories, and the time commitment required for ethnographic study, suggesting that perhaps only doctoral students have the opportunity to carry out such studies (Peerbaye & Vinck, 2025, p. 50). While there are very few studies of the information practices of scientists working in a laboratory (Jones, 2005; Peerbaye & Vinck, 2025), some studies of the information behaviours of

scientists such as physicists, chemists and biologists do exist (see section “Scientists and Their Use of Information”, in the Literature Review chapter) and are of value for comparative analysis. Thus, the data collected in this study and presented in the findings are, in and of themselves, a contribution to the literature in Information Practices.

This study drew on conceptualisations from Actor Network Theory (ANT), in particular adopting the position that objects, that is non-human agents, can be actors in interactions, that can influence and shape the actions of humans, and have an impact on information, its creation and flow of information and knowledge. ANT is not commonly used in studies of information practices, however, some authors in recent years are engaging more with these ideas, such as Pilerot (2014a), Kwon, (2017), Ekström (2024a), Gullbekk (2021). This study adds to that small group of studies.

Creating an Epistemic Culture

This study builds on the work of Knorr-Cetina (1999). The findings show that the scientists at the centre of this study have a noticeable epistemic culture and how that culture is created. Each of the four key features of an epistemic culture that Knorr-Cetina identified is clearly evident in the practices of the scientists in this study. These features are focus on knowledge creation; a particular way of thinking and relating scientific knowledge to the real world; a set of intellectual tools and social conventions; and an explicit context for knowledge creation. In this section, I touch on each of these, linking it with evidence from the findings, to reveal the epistemic culture of these scientists.

These scientists have a clear focus on knowledge creation. They seem to know what is expected from them in their chosen profession. The importance of this focus on knowledge creation is perhaps clearest in the examples of the two scientists who explain their desire to maintain their scientific work in the face of obstacles. Reza describes how he shifted to focus on bioinformatics as a way to

stay engaged with the field, and Leah expresses her anguish at the conflict between the demands of science and the demands of motherhood.

The findings support the claim that laboratories are influenced by external domains of interactions. They show that not only do centres of knowledge creation, like this scientific laboratory, affect knowledge in societies, but that societies also have a shaping effect on their information practices (Peerbaye & Vinck, 2025), because scientists and others involved in scientific work live in a plethora of domains. The research of these scientists attempts to find solutions to real world problems as Silvia and Nestor note when they refer to the work they do with commercial partners. In the findings, the vignette “Mimicking the Natural Order” shows the efforts the scientists go to recreate key aspects of the natural world in their experiments, so that they can solve real world problems.

This bi-directional effect that scientists and their work (i.e. advances on counteracting multi-resistant bacteria) could have on society and society could have on scientists and their work, for example, new techniques, or safety regulation, can be understood in part as resulting from the commercial relationships they identify and in part from their concern with communicating their results beyond the readers of scientific journals (Joubert et al., 2019).

Taking up Knorr-Cetina’s second feature, the scientists have their own way of thinking and relating theory and practice. This way of thinking derives from the concept that I have labelled Echoform. This concept is fundamental to their research and is evident in the interviews with the researcher, media statements and their scientific papers. The concept, with its emphasis on social behaviour, shapes their interpretation of their observations and leads to the use of anthropomorphic and other figurative language, such as digging trails or altruism, to explain findings. This way of thinking and their use of Echoform as a conceptual framework, sets them apart from the way the large portion of microbiologists would record their observations of bacteria, which is based on their morphological or chemical constituents rather than through their behavioural dimension (Shapiro, 2007, p.807; Ben-Jacob, 2008, p.315).

The intellectual tools used by these scientists mark aspects of their particular epistemic culture. The findings show the influence of Professor Karen's approach to the research, bringing a flavour and colour that was local to this group of scientists, as she herself mentioned, being one of the first applying the concept of Echoform to bacteria. This application added a social layer to the bio-chemical understandings that are widely accepted in the field. Observation is an important practice in this laboratory. At first glance, neither observation nor microscopy would strike anybody as a distinctive feature of a microbiology laboratory. On the contrary, one might readily argue that those practices are integral parts of any microbiology laboratory (cf Weber & Huiskens, 2021). However, for this group of scientists, their practices of observation and the facilitation of such practices via the microscope, were foundational to the way they went about their research, their findings and ultimately their view of the bacteria. Even though they might employ the same techniques as scientists in other laboratories, such as sequencing or observing via the microscope, they report that their practice of observation had an additional component that was the expectation that they could observe the bacteria's "behaviour", that if they could "stare" at them, they would be able to learn from their "behaviour", in the same way that they might understand human behaviours if they were "Sitting at the Train Station- The Practice of Observation", the title of one of the vignettes. Professor Karen's passion for the work of van Leeuwenhoek and his concern for direct engagement with his subjects of study, which she saw as standing in opposition to much contemporary scientific practice in microbiology, gave an insight into how she had developed this intellectual tool of observation and of microscopy in more junior members of the group.

Their practice of observation was more complex than interpreting signs or signals from the technology or the bench experiments, and thus they needed an intellectual tool to express these observations. The use of figurative language (Knorr-Cetina, 1981), and the conceptual context of Echoform, is such an intellectual tool. The development of this social discourse, as explained above, can be traced back to Professor Karen's vision for research in this area, and it

has become one of the most distinctive components of their discourse, both internally and also in their material produced for the general public.

The relationship between the scientists and non-human actors, especially with the microscope and the bacteria, which have an influence on the environment of the scientists by translating and transforming it, is expressed in figurative language (Knorr-Cetina, 1981, p.49). This study has shown that not only is the social environment extended to include these non-human actors, but furthermore, that these non-human actors have agency and make contributions to the research outcomes in their interactions with the scientists (cf Latour, 2005, see also the sections “Entering the Special Room and Meeting the Microscope”, “Tales of a Microscopic Organism – The Social and Clever Bacteria”). The practices demonstrating the use of intellectual tools, like the use of analogy, figurative language, anthropomorphism and storytelling can be seen in vignettes such as “Sitting at the Train Station – The Practice of Observation”, “Entering the Special Room and Meeting the Microscope” and “Tales of a Microscopic Organism – The Social and Clever Bacteria”.

Another intellectual tool is the process that Latour refers to as transformation (cf Latour, 2005, see also the section “Latour and Actor-Network-Theory (ANT)” in the Literature Review chapter). This study provides empirical evidence of the practices of scientists as they capture observations as handwritten notes before they move to computers or save microscope files into a group or personal taxonomy (see the section “The Buffer Zone” in the Findings chapter). The transportation of notes with personal notations and colour coding from the laboratory bench to the desk area, is an exemplary instance of morphing observations into documental entities to be mobilised, or “immutable mobiles”, as Latour calls them (2005, p. 226). This finding is similar to Haider and Kjellberg (2016)’s findings when they inquire for the moment of transformation of observations to be consolidated into a form that could be stored.

The approach to writing academic papers demonstrates the intellectual tool of storytelling rather than the focus only on reporting of scientific observation data

(Joubert et al., 2019; Matei & Hunter, 2021). For these scientists, academic papers are not a set of disparate data, but a representation of the phenomena investigated, and from the moment the research is postulated in the form of a hypothesis to the final approved academic paper, for them there is a thread of a story that can be confirmed, modified or debunked based on the interaction of scientists within their investigation with various actors. This is important because, in contrast to traditional scientific papers that focus only on reporting observational data, this group of scientists constructs academic knowledge through storytelling. Their stories make sense of findings obtained via experimentation and are continually shaped by reciprocal interactions with other actors, connecting the initial question with the findings and the bacteria's behaviour (Matei & Hunter, 2021, p.312). For example, while a traditional paper might simply report the growth rate of bacteria under certain conditions, this narrative approach would explore how these findings fit into a broader understanding of bacteria's behaviour. This distinction matters because it illustrates a more dynamic and context-rich process of knowledge creation, where knowledge emerges not just from data, but from the interplay between observations, interpretations and interactions with multiple actors and domains.

Academic papers present a technical story of the phenomena studied by scientists, this does not mean that is only an intellectual story developed through the knowledge and expertise of the scientists. But that is also a performative story that is co-authored by the constant interaction between scientists and non-human actors, as they engage with each other, dancing through a process of resistance and accommodation (Pickering, 1995). Thus, this investigation concluded that the scientists were creating stories that explain the phenomena of investigation, as is shown in vignettes such as "Tales of a Microscopic Organism – The Social and Clever Bacteria" and "Constructing the Story – From the Desk to 'Publish or Perish'".

Epistemic cultures are sensitive to the context that shapes knowledge creation. Latour and Woolgar's (1986) study arrived at the conclusion that laboratories are in the business of writing or typing, from which the main output is the

construction of the academic paper. A similar finding emerged in this investigation, confirming the widely accepted view that academic papers are an important output of research and the means by which knowledge is finally consolidated as authoritative to be presented to the public. However, this present investigation found that the practice of writing or typing described in the study by Latour and Woolgar (1986) was quite different from the practices of this laboratory. The technological means by which observations can be stored and moved around different areas of the laboratory in this present study means that writing itself as a predominant information practice was no longer as evident, as it was in a laboratory in the 70s, where secretaries were constantly typing papers or other communications. What was evident in this study, was that the scientists relied on their computer and digital means to create the text of the research paper themselves (see the vignette “The Buffer Zone”).

Another aspect of the context for these scientists is the expectation that scientists will gain experience in different laboratories around the world. The findings show how this expectation has influenced the backgrounds of the scientists from this group who took part in the study, and is evident, for example, in Lucia’s concern that her visa status makes her ineligible to apply for research grant funding (see the section “Post-Doctoral Fellow” in the Findings chapter).

This brief overview of the epistemic culture of the scientists who took part in this study, using the features of an epistemic culture identified by Knorr-Cetina (1999) confirms the lasting significance of Knorr-Cetina’s laboratory study and its value in identifying a culture of knowledge production in a contemporary setting. As Knorr-Cetina (1999) argued, different cultures may configure local practices in their own fashion. This study suggests a richer picture of the local epistemic culture of this group can emerge from a reconsideration of their information practices, as detailed below through six different aspects of these practices.

The Localised Epistemic Culture of this Group of Scientists

Six aspects of the information practices are highlighted here as constituting the epistemic culture of this group of scientists. They are not presented as unique to this group, but taken together, they indicate those features that members of this group would acknowledge as being in some way particular to them.

The first aspect is the social nature of their practices, underscored by researchers in information practices including Talja (1997, p.70), Lloyd (2010, p.251), McKenzie (2003, p.24), Savolainen (2007, p. 210) and Olsson (2010, p. 273). This aspect is evident in how observation has become, as reported by them, their foundational practice. This is evident through their constant reference to their “love” of observation, which highlights the importance of the practice and the technology that affords this practice, the microscope. This “love” of observing the bacteria’s behaviour, evident in the vignette “Sitting at the Train Station – The Practice of Observation”, clearly derives in part from the leader of the laboratory and her fascination with the first principles established in the late 17th century by the pioneer of observation, and father of microbiology, Antonie van Leeuwenhoek. In the interactions with the group, their inclusion of references to observation does not seem to be at all forced, but on the contrary, something that is communicated by interactions and examples.

The second aspect is first made evident through relationships with the microscope, which is clearly an important actor in Latourian terms (see the vignette “Entering the Special Room and Meeting the Microscope”). This relationship with the microscope does not exist in a vacuum, it brings in another set of non-human actors, the bacteria, as well as a different element, a concept I have denominated throughout this investigation to maintain a level of de-identification, Echoform (see the section “Discourse as Information Practice” and the vignette, “Tales of a Microscopic Organism – The Social and Clever Bacteria”). Echoform, as noted elsewhere, provides a conceptual foundation for the research of the laboratory, and, importantly, a vocabulary to think about the

bacteria and express the scientists' observations of experimental interventions in social terms.

The third aspect highlights the discursive practices they have developed for encapsulating the bacteria's behaviours and communitarian life in a coherent manner via discursive framing, through the use of anthropomorphic and metaphorical language. Pickering's (1984) description of the establishment of Quarks presents us with a detailed example of how scientists' social practice and the use of language as a conceptual framing mechanism shape theory and help to make sense of their observations. Knorr-Cetina (1981, 1999) and Latour and Woolgar (1986) make a similar observation, and both describe how scientists use language as a mechanism to stabilise theory and understanding. This study has observed scientists using Echoform as a foundation, leading to the development of a localised social language about the bacteria and the microscope that brings to the traditional description of the bacteria a social dimension that enables the scientists to elucidate social and communal theories about the bacteria's behaviour (see the vignette "Tales of a Microscopic Organism – The Social and Clever Bacteria"). There has been some interest in information practices research with how social cultural arrangements facilitate the development of discourses around practices, so that the local particularities of practices are distinguishable, and the communication of such practices emerge in ways that affords them to transmit the inherent concepts. Authors, such as Lloyd (2009, p.417; 2014, p.3), Olsson (2010, p.273) and Yerbury and Henninger (2025, p.308) have focussed on the cultural discursive arrangements of social groups.

The fourth aspect is their strategy for sharing findings through storytelling (Joubert et al., 2019; Matei & Hunter, 2021). Studies such as those of Olsson and Lloyd's study of car restorers (2016) indicate that members of a social group may have their own vocabulary for internal communication, and a way of explaining their expertise to outsiders. Initially, I assumed that the metaphorical discourse was a strategy for communicating with non-experts, like the general public, as this discourse is found in media releases and in recorded interviews

and broadcasts, but for these scientists, this was not the case. They used the same figurative discourse among themselves, although this did not negate that they also had a very strong technical bio-chemical and bio-information language. However, this use of figurative language does seem to indicate that this technical language is inadequate to express their findings and the way in which they experience their investigation and thus they have developed their own discourse to convey their findings. As we have learned from Lakoff and Johnson (1980), metaphors and other figures of speech help us to stabilise abstract concepts through everyday language. While this information practice may have been observed in STS (Pickering, 1984, Knorr-Cetina, 1981, 1999), it is not a common finding of the research in Information Practices.

This discourse is used for the purpose of storytelling; a practice members of the group take into account even to underpin the development of scientific papers. They do not make a significant distinction between the approach to writing scientific papers and communicating with funders or the general public. Even though their scientific papers are presented with data and technical vocabulary, the participants were always indicating that there was a story thread from hypothesis to the final document that needed to be supported by the data (See the vignette “Constructing the Story – From the Desk to ‘Publish or Perish’”). This finding also extends our understanding of the information practices of scientists, as presented to us through Latour and Woolgar’s description of *Laboratory Life* (1986), where the writing of scientific papers appears as an internal process, based on the conventions of the reporting of experiments.

The fifth aspect entails how physical location shapes information practices within the laboratory (cf Schatzki, 2002, p.64; Cox & Fulton, 2022) and is highlighted in the vignette, “Entering the Biological Laboratory” (see also the section “Location Affects Information Practices” in the Findings chapter). This vignette shows that there are certain practices and attitudes that are particular to certain spaces. All the members of the group seem to have an understanding of how to conduct themselves appropriately within the given space. A concern with how location may determine the information practices of its inhabitants is

common in information practices research. Olsson's work with archaeologists provided a helpful insight into how the location, such as archaeological sites, may constrain or create new opportunities for local and contextual information practices to emerge (Olsson, 2010; 2016). Latour and Woolgar (1986) identify the area in the laboratory given over to typewriters and typists as evidence of a particular focus on the production of scientific papers.

Technology and its placement were important in this study. The scientists emphasised the importance of the spaces allocated to the microscopes for their observation of the bacteria and the significance of the computers in the desk area for the finding and accessing information resources and data, as well as writing. During this investigation, the constraint imposed by the prohibition on electronic devices in the laboratory brought to mind the question of how the scientists moved their observations and findings to the desk area. The answer was that a mixture of practices existed, a hybrid of shared practices, that in this case are mandated and explicitly communicated via training, and but also influenced by personal mnemonics, as tools to freeze their observations into documental pieces (Latour, 2005) that can now be moved through different zones and become material for their analysis, or data. This reflexion on the constraints of space, and human movement through different spaces, brought a new insight to the understanding of information practices, namely how the physical context shapes information practices and the need to mobilise findings to other areas. The practices for people and data moving from one space to another may be documented and shared through training for newcomers to the laboratory, but, in the end, these practices are inadequate for the everyday experiences of the scientists, and they have developed their own idiosyncratic practices (Shankar, 2004; Ellis, 2016; Jones et al., 2017).

The sixth aspect this study has identified as part of the local epistemic culture is the existence of domains of interaction. These are places which could be external to the laboratory but remain connected with the scientists and have been found to have influences on their information practices. This could be seen as somewhat similar to Knorr-Cetina's feature of the explicit context of

knowledge creation. These scientists often brought into their information practices systems and places from outside the laboratory and often from outside of their scientific research. Latour (2005) was also concerned with moving agency across sites, but the use of the analytical tool of the Cosmic Zoom in this research, showed that the participants of this study had the ability to remain connected to a site and at the same time to summon experiences happening in other domains of interaction. This new concept developed through this investigation will be explored in greater detail below, in the section “A New Concept ‘Domains of Interaction’”. That this aspect of an epistemic culture has not been identified as significant before may be because it draws from McKenzie’s (2003) concern with ELIS. Here, instead of considering discussions of childcare or visa status as being unrelated to the information practices of these scientists (see vignettes such as “Negotiating Life and Science”), these discussions, which move the focus outside of the laboratory, are nonetheless seen to be central to information practices, highlighting other aspects of knowledge and expertise that the scientist have, or that they must integrate with their practices as scientists.

These aspects of the localised epistemic culture are expressed by the group as a whole, but it is clear from the interviews with Professor Karen, and statements from the other scientists that the epistemic culture of this group has come into being from the conceptual understandings and practices of Professor Karen, as leader of the group, and the training, support and mentoring provided to junior scientists by Silvia. The significance of the approach of the leader of a laboratory in setting the culture of a group was a factor noted by Knorr-Cetina (1999). The focus on storytelling, while clearly championed by Professor Karen, was being discussed widely at the time of the data collection in the context of science communication, as the paper by Joubert et al. (2019) shows.

The Information Practices of Scientists

The next three sections discuss the study from the perspective of information practices. The first presents the findings of the information practices of the

scientists in the context of studies from Information Behaviour and information practices. The second and third take up the aspects of embodiment and affect found in the information practices of this group of scientists.

Information Practices and the Literature

Research on the information behaviours of scientists has a long tradition, while the literature on Information Practices research has been developing over more than twenty-five years. However, Jones (2005, p.88) noted that more research was required on the actual practices of scientists performing their research activities, and twenty years later, although there have been studies of the information practices of scholars including academic scientists, that is, scientists who teach in universities, there have been very few studies of the information practices of laboratory-based scientists. Here, these practices of the research group, presented in the previous chapter, are compared with the findings of previous studies.

This study found that scientists normally interact with electronic and online resources as part of their scientific practices. The vignette “Constructing the Story – From the Desk to ‘Publish or Perish’” shows the significance of the computer as a tool to access digital resources, and the section “Accessing Information Resources” shows the scientists interacting with genetic databases such as BLAST among others digital tools. We can see many instances but specifically in Reza’s, Nestor’s, and Leah’s interactions, where they point to the computer and databases, as major technologies for searching and finding information for their research. The adoption of electronic and online resources for searching and accessing information has been a growing trend in the information behaviours of scientists, and other scholars, since access to the internet became commonplace (Roos, 2015; Hemminger et al., 2007; Palmer et al., 2009; Haines et al., 2010; Niu and Hemminger, 2012; Sahu & Singh, 2013; Kwon, 2017; Devi and Lawanda, 2023). This increasingly paperless environment is completely different from the one observed for example by Latour and Woolgar (1986) or Ellis and Haugan (1997, p.395,398).

Searching for information or accessing it no longer involves going to the library. However, this does not mean that the scientists do not use the services provided by the library. They referred to their reliance on scientific reports and journals as background information for hypothesis elicitation and researching experimental techniques (see for example Lucia's comment in the section "Accessing Information Resources" in the Findings chapter). This lack of visits to the library is the end point in a decreasing pattern of using library services that has been observed by Hemminger et al. (2007), Haines et al. (2010), Niu and Hemminger (2012), Kwon (2017) and Devi and Lawanda (2023), and also highlighted by the Research Information Network in their study (2009, p.47). While earlier studies considered ways in which librarians could change the services they offered to bring researchers back to the library, and considered the decrease in visits a decrease in dependency on library services, as noted even in the study by Roos (2015), for the scientists in this study, which is focused on the practices of scientists rather than on librarians and the services they provided, it was taken for granted that the literature and other resources they needed, were accessible to them through their computers.

Sharing information was important to this group. The findings show a number of practices including face-to-face and informal opportunities, for example, during lunch, team meetings and even in collaborations with other teams. On the surface, these practices are similar to those documented in previous studies (see Ellis & Haugan, 1997; Hemminger, 2007; Haines et al., 2010; Niu & Hemminger, 2012; Sahu & Singh, 2013) that have reported personal contacts, both internal and external, as important avenues for collaboration, sharing information and keeping up to date. In this study, when examples of information sharing emerge, for those outside of the laboratory, information can be understood as something intangible, ideas, for example, whereas information sharing with other scientists in the group is more likely to refer to information as something material, the possibilities of sharing data stored in the group's common drive (cf Pilerot, 2012) The anecdote told by Professor Karen about sharing her ideas over a beer demonstrates the value of trusted colleagues in the context of a research conference (see the section "Sharing Information" in

the Findings Chapter). Yet there were differences with the findings from previous studies. It did not seem that these scientists actively shared information to keep up to date, rather they knew who else was carrying out research in the same areas and through informal means, they kept abreast of the work of those groups. Information sharing for this group was a purposeful activity, aimed at developing and expanding collaborations, including with commercial partners.

Other studies (Niu & Hemminger, 2012; Kwon, 2017; Gordon et. al., 2022) found differences in the patterns of use between the senior scientists and the more junior, and Leah remarked that her circumstances meant that to some extent now she saw herself as a research assistant to Professor Karen. However, in this study, it seemed that efforts were made to minimise these differences. While it was clear that the senior scientists in the group had access to a stronger network of experts than the newer scientists, Nestor, probably the most junior of the group, remarked on how he was sent to meet with potential collaborators and Silvia is shown to have responsibility for training research students.

This present investigation identified the tendency of participants to enact their personal information management practices in parallel with group practices to resolve their own particular needs. This emphasis on individual ways of handling information, evident in ways scientists transported information from the experimentation area to the desk area (see the vignette “The Buffer Zone”), is not a feature of most studies of Information Behaviour, where a focus has largely remained on externally created information resources. Yet, we can see a corresponding finding in Jones’ (2005) study, which highlights how both practices can coexist.

Jones’ practice theoretical approach allowed him to focus on individual, or what he calls cognitive tasks, as well as social tasks (2005, p. 89). From this approach, he was able to show the steps and stages of the research process, and the information practices associated with each stage. The scientists in the

study put significant emphasis on planning for their experiments (see for example the comments of Lucia, Silvia and Leah in “Mimicking the Natural Order”). They considered this an individual responsibility, and emphasised this planning, and the associated management of their diaries. This emphasis on planning is reminiscent of Jones’s first stage in the research process “managing research”.

One of the critical findings of this investigation presented in the sections “Locations Affects Information Practices” and “Entering the Biological Laboratory” is that physical places and geographical locations affect the information practices enacted in them. This investigation found that different physical places create different social contexts, in which scientists perform information different activities, this finding is congruent with Cox and Fulton (2022), who have found that physical places shape information behaviours and information activities provide social meanings for how those activities are performed.

Yet, in spite of the similarities in findings between this study and other studies, it is important to keep in mind the findings from the Research Information Network study (2009) into the information practices of research scientists in the life sciences, that explains that differences in information practices among and between groups were of greater significance than the similarities. The next section illustrates this through embodiment and affect as information practices for this group of scientists.

Embodiment as a Practice

Information Practice scholars have demonstrated how the body and senses are relevant when it comes to constitution of information practices. Research in Information Practices helps the reader to understand how embodiment and affect play a crucial role in how individuals engage fully in making sense, sharing and using information (Gherardi, 2017; Lloyd & Olsson, 2019; Savolainen, 2014; Talja, 2010). This study shows that the constitution of information practices for the construction of knowledge is not only a localised

and situational aspect of practices, nor only the outcome of the pull and push of forces seen from the perspective of humans acting and interacting. It goes beyond this and reveals a fully involved everyday way to cope with reality as the currency of relationships, both with the environment but also other human and non-human actors. This is at its very core relational, and the way scientists in this study cope with the influences from these relationships, the environment and other domains of interactions, often requires engaging the body in information practices. This indicates that information practices are not only intellectual but involve a degree of physicality that demonstrates skill and expertise and tacit understanding (Knorr-Cetina, 1999, p.99).

It has been clear through this study that the scientists are physically engaged with their environment. What is evident during the interactions observed, is that that the body and senses are in themselves sources of information and an active part of the process of information construction, in a tacit and natural way in which the individual relates with their environment, as Lloyd and Olsson (2016) observed.

We can see Leah, Lucia, Nestor and Silvia engaging on the bench with their samples, getting cues from the colour, the shape, and the smells, as noted in the vignettes such as “Sitting at The Train Station – The Practice of Observation” or “Entering the Special Room and Meeting the Microscope”. The study has also provided examples of what Pickering has called the “dance” of resistance and accommodation (Pickering, 1995, p.22), clearly a metaphor of embodiment, as a mechanism to adapt to the actions of other actors in the environment.

The content analysis of the data allowed me to identify embodiment of practices, in which scientists use their body, not as a sensor or apparatus for feeding in signals to the brain, but as a means of enquiry and information processing in itself, including emotive and embodied responses.

Affect as a Practice

This study shows how affect plays an important role in how scientists engage with the world when making sense of it and constructing new knowledge. This seems to be in keeping with studies in which scholars have highlighted the importance of affect in Information Behaviour and practice (Lloyd, 2009; Olsson, 2010; Savolainen, 2014; Leith, 2019). The ethnographic approach used in this research illuminates how participants engage with their socio-material environment, not only through cognitive and embodied perspectives, but also using affect, both during observation and during the interviewing process.

The growing interest in affect by researchers taking a practice approach has been highlighted by Knorr-Cetina (1999) and by Gherardi (2017) and in information science by authors including Lloyd (2009), Savolainen (2014), Olsson (2016), and Leith (2019), with studies seeking to understand the role that affect plays on “knowing” as a product of the interaction with multiple actors and the environment (Gherardi, 2017, p.348-349).

In this study, affect is not considered only as an internal phenomenon, private to the scientist, but exteriorised through emotive and corporeal responses, as part of a broader experience in relation to the practices of investigation and to the interaction of the scientists with their social context, as Gherardi proposes (2017, p. 353). From this perspective, researchers, like Lloyd (2009) and Olsson (2010), trace a direct relationship between embodiment and affect in terms of information practices. They argue that corporeality, the use of sensorial interaction with the environment, is deeply related with how human agents affectively cope and respond to their context (Savolainen, 2014, p. 60).

This much is evident throughout this investigation, the full spectrum of information practices scientists display seems to encompass not only intellectual and physical activity, but a distinct affective response that could also be determinant in how information practices are instituted and how scientists cope with their environment. However, the fact that these three domains are inter-related, does not mean that they are the same, as many authors (see for

example Knorr-Cetina, 1999; Lloyd, 2009; Olsson, 2010; Savolainen, 2014; Gherardi, 2017) have pointed out in a number of fields, including Information Science and STS as well as organisational studies, many of them building on the work of Schatzki's (2002) Practice Theory.

Throughout vignettes such as the ones under the section "Living in Other Domains", the findings suggest that the scientists may act in one way or another because they feel compelled to do so, either by fear, personal benefit, parental affection or because it is important to play the game (see the vignette "Playing the Game – At the Mercy of the System"). Whatever the reason, there must be an internal imperative that acts as a burst of energy (Latour, 1986, 2005), by which the scientists modify their information practices to accommodate to a new set of influences from other domains, so that their emotional state appears to compel them to reconfigure the way in which they use, share, save information to manage all of the influences in their environment.

One clear example of this can be seen in the pressure scientists feel to publish, the so-called "Publish or Perish" syndrome, reported in the vignette "Constructing the Story – from the Desk to 'Publish or Perish'". This laboratory, like others in Australian universities, functions by a system of grants and the product of investigations is evaluated in large part by published papers. Therefore, there is significant pressure to publish in journals regarded as good. This pressure may have an impact on how the scientist represents her work and how the resulting story in the paper is presented. The vignette shows how Leah described certain feelings of frustration and uncertainty about the best way of presenting negative data and constructing the story. Negative data, Leah tell us, confirms what is not, rather than what it is, and she feels apprehension that at the end she may not have enough for an academic paper. In this vignette, what becomes evident is how their interactions and the weight of the evidence from their observations causes the scientists to re-calibrate, corroborate, and adjust those stories that had begun as a hypothesis, and transform them into what finally becomes an academic paper.

An Innovative Analytical Approach to Information Practices Research

The Cosmic Zoom & Domains of Interactions

The Cosmic Zoom analytical tool developed through this study, finds its original seeds in the ideas of authors like McKenzie (2022) and Horton (2021) and it is illustrated by the Canadian film *The Cosmic Zoom* directed by Robert Verrall (1968). The film communicates the efficacy of zooming in and out on the detail at different frames of magnification.

The following section provides an explanation of the Cosmic Zoom as used in this study, which has helped me to make sense of what I observed. The approach proposed here has evolved from the original notion of Professor McKenzie's Cosmic Zoom, to involve a larger scope and more complex set of implications. Nevertheless, the original name Cosmic Zoom remains. This aligns with Horton's (2021, p.3) argument that scale should be seen as a mechanism for framing and mediating relationships with non-human actors and domains.

The Cosmic Zoom uses the metaphor of magnification, a technical practice which is essential to the work of the scientists in this study. Using the terminology of the Cosmic Zoom, this investigation begins at the meso level, at the home-frame, and uses the three levels of micro, meso and macro. It is important to note that these categories – micro, meso and macro – are not related to the social analytical distinctions found in sociology. In this research, the tool identifies the level of magnification, or scale, participants are at. It also allows for the level of agency to be revealed. Here, the meso level accords with the laboratory, Verrall's home-frame. This is evident, as the scientist is the focal point during practice at the bench or during microscopy sessions in the lab. However, as happens when adjusting the focus at the microscope, variations of frames can shift the focus of observation, to the actions of the microscope or

bacteria, or to the concerns with immigration, grant applications or motherhood. At the same time, the shift in magnification can move the scientists' agency out of focus, moving that leading role to the periphery, as the scale goes from meso to a micro or macro level of resolution.

Thus, the analytical tool of the Cosmic Zoom allows the researcher to "travel" with participants across sites, identifying the relationships to external sites that may affect them. As used in this study, the Cosmic Zoom brings a number of innovations to our understanding of Schatzkian Practice Theory and Information Practices, such as the ability of seeing information exchange, agency and practices from a scalar perspective. Further, it has clarified the limitations of concepts established by including Latour and Schatzki, especially their positions that accept relationships and interactions as taking part in a single plane (Harman, 2009; Schatzki, 2016; Spaargaren et al., 2016; Whittle & Spicer, 2008). In what follows, I discuss some of the ways in which this analytical tool has highlighted concepts and their application of value for research in Information Practices.

At the Centre of Agency – The Use of the Dance of Agency

The metaphor of the "dance" as proposed by Pickering (Pickering, 1995), has been used to understand how non-human actors shape and influence scientific practice during the construction of knowledge. The findings demonstrate that the microscope exerted a palpable influence on the social environment, even influenced the scientists affectively; they also show how the scientists operating with the microscope were engaged in a communicative interaction with the microscope and its presence, as they attempted to observe the bacteria (see for instance the vignette "Entering the Special Room and Meeting the Microscope"). Using the Cosmic Zoom, one can see how the focus shifts in level of magnification, with the actor as the centre of the focus.

The metaphor of the "dance of agency" (Pickering, 1995) encapsulates, practically, what Latour and Knorr-Cetina explore in that reconfiguration and relationship with non-human actors. It proved to be beneficial here, as it

illuminates the ways in which scientists implemented localised practices, for example of observation, and the co-operative engagement with other actors, including the microscope, that enabled them to refine or readjust their hypothesis. Pickering (1984, 1995) explores interaction and negotiation between human agents and technology or non-human agents in general, as a way of grasping reality in a performative way. His statement “We act in the world, and the world acts on us” (Pickering, 2017, p.136) frames this reciprocity in which we affect and are affected by our environment. This was evident in the findings of this investigation, in both the bench and the microscope sessions where the participants interact and negotiate. One can see how the bacteria and the agency of the microscope shape the contours of the knowledge of scientists as it is being constructed (see for example the vignettes “Entering the Special Room and Meeting the Microscope” and “Tales of a Microscopic Organism – The Social and Clever Bacteria”). This also indicates that knowledge is not only an intellectual endeavour, but that its construction involves interaction with the environment and the material agency around the scientists (Pickering, 1995; Knorr-Cetina, 1999).

The metaphor of the “dance of agency” is especially useful when technology is involved, since it provides the researcher with the capacity to delve into the specifics of interactions between human actors, their goals, and the specific hurdles that are presented to them during investigation and the practices that need to be employed to overcome or accommodate circumstances and the demands of non-human actors.

Nevertheless, the findings of this study also indicate that the metaphor of the dance was perhaps less effective when following actors across different frames of magnification or to other domains. This is because the metaphorical tool of the dance, even though helpful in examining those interactions between participants and technology that affect the scientists’ information practices at the meso level of magnification, is limited when moving to other levels of resolution, as when increasing to macro-level frames. This is because at the dance, actors are at the centre of the action and engaged directly in a choreographic and

direct negotiation with other actors within their surroundings. The actors, therefore, enter in a process of constant negotiation, or as Pickering (1995) calls it, “resistance and accommodation” with such objects in their environment. At the macro level, in most cases, the scientists and the systems such as immigration or research funding have no scope for resistance and accommodation; individuals only have compliance or rejection as options for action. The tool of the dance as an explanatory metaphor therefore lacks “scalar alterity”, as Horton puts it (Horton, 2021), as it is difficult to apply at the micro or macro-level.

A New Concept “Domains of Interaction”

The use of the Cosmic Zoom approach as an analytical tool allows the researcher to acknowledge that individuals live and remain simultaneously connected to different sites or domains during the performance of their scientific tasks and to consider that the seeds of knowledge construction could in some instances be transported and traced back across multiple sites, (Latour, 2005; Schatzki, 2002, 2003) and across time and space (Haider & Kjellberg, 2016). In this investigation, I have adopted the terminology “Domains of Interaction” to label those other spaces beyond the site of observation, in which individuals also live and interact. This new conceptual understanding allows me, as a researcher, to accept all accounts from participants at face value and to see these places as potential sources of influence on the information practices of the scientists. In coming to this conclusion, I included in the analysis the entirety of the accounts, regardless of whether they were technical descriptions of a scientific practice, off the cuff remarks, rants or mundane complaints about their relationship with other systems or were referring to aspects of their life that may appear on the surface disconnected from their practices in the laboratory. Therefore, this new concept allowed me to name the domains as I “moved” with the participants, following them in their accounts.

The adoption of this new concept is not just the adoption of a new term. The acknowledgement that agency permeates across multiple sites (or domains of

interaction) is an assertion that brings to the fore domains that are apparently disconnected, or far removed from the laboratory, but which seem to have an influence on the scientists' information practices and construction of knowledge. This in turn extends the focus from that on observation at a local site, that is typical in studies using information practices, to encompass other sites that may have an impact on the information practices (Van House, 2004; cf Nicolini, 2009; Pilerot, 2014a).

The Cosmic Zoom not only allows the researcher to be able to move with the scientists across multiple domains by following their accounts and adjusting the degree of magnification. It also opens the social space, not only, as ANT suggests, to non-human actors (Latour, 2005), but furthermore, as agency is understood more broadly, to include other forces acting on the environment.

Transporting and Translating Agency Across Domains

The tool of the Cosmic Zoom enabled me to follow the processes through which information was mobilised across environments, as data and influence were documented and moved across domains. As noted earlier, this study provided an example of how Latour's immutable mobiles (2005, p.226) are transported. The tool highlighted interactions involving scientific data being stored, cared for and made available to others. For instance, the vignettes "Deconstructing the Bacterium – Dr. Reza's Story", "Entering the Special Room and Meeting the Microscope" and "The Buffer Zone", all show how data were made into artefacts such as documents or notes and became transportable. In other words, this analytical tool was able to show how there is not a single "magic moment" when data is created (Haider & Kjellberg, 2016, p. 143), but a number of instances where observations are transformed into documental entities which will remain available across time. This interpretation is congruent with Haider's and Kjellberg's observations (2016) and similarly, with Knorr-Cetina's (1999) observation regarding how objects of study in a laboratory mutate from being material objects to being transformed into multiple forms across various stages, including data, graphs, laboratory notes, images, representations in the

microscope monitor, and so on.

The Cosmic Zoom approach can also be beneficial to analyse how information practices can vary due to the social interaction of actors with their environment and the larger set of domains in which they participate. The Cosmic Zoom approach, used here and proposed for future use in information practices, recognises the complexity of a populated environment, while also acknowledging that such environments can be viewed across time and space in varied frames of magnitude. In so doing, the Cosmic Zoom acknowledges that agency might be transported across levels of magnification, as we zoom in and out (Nicolini, 2009; Jensen, 2021; Horton, 2021). However, the researcher is able to unfold such scales, not by jumping across gaps and assuming already constituted societal causes (Latour, 2005), but by moving across the domains with the participants, following the thread of their accounts by adjusting the framing of magnification, as, in their information practices, they themselves transport, translate and transform data and information.

Operationalising the Cosmic Zoom and Escaping Flat Ontology

The Cosmic Zoom metaphor of zooming in and out is based in the process of microscopy. In contrast to Latour's cartographic metaphor that is ontologically flat, it provides the social researcher with the ability of zooming in or out, as it were, to follow participants' accounts through multiple domains connected through their relationships, technology and within circumstances, at times beyond their control. As such, it encourages a re-thinking of the concept of site in Schatzki's Practice Theory and also allows a deeper understanding of Latour's notion of networks.

The conceptual frameworks proposed by both Latour and Schatzki are ontologically flat in that they see the social interactions happening at a single level or plane of social reality (Latour, 2005; Schatzki, 2016; Loscher et al., 2019). For Schatzki, the social happens within the social site as social practices occurring in a context permeated with meaning and material arrangements (Schatzki, 2016, p.32; Loscher et al., 2019, p.118). On the other hand, for

Latour the contours of the site are shaped by the relations among actors, where non-human actors are not part of the background but actively participating in the relationships within the dynamics of the network (Latour, 2005). Schatzki's insight (2002) about sites as contextual social places is important, because it allows the researcher to follow the actions and accounts to places that go beyond the confines of the physical site, following the interactions of the site. As Latour (2005) indicates, ripple effects on the local site could be derived from other domains (Latour, 2005, p.166). In Information Practices research, the focus has mostly been on the local site of observation (McKenzie, 2022), primarily centred on the social context of participants, with practices being conceptualised as happening there and then (Olsson, 2010). However, studies by Yerbury, Perera and Olsson (2022), Haider and Kjellberg (2016) and Pilerot (2014a) are some of the instances that show that context can exist across time and space, including being temporary or even fleeting.

This investigation makes a distinction between the site where the social investigation was performed and the ethnographic method was implemented, that is the laboratory (the home-frame or meso level), and other sites where scientists also live and interact but that may be external to the laboratory, in this study referred to as Domains of Interaction. To all intents and purposes, the home-frame is coincidental with the laboratory as a physical place (cf Schatzki, 2002, 2003). The distinction between the home-frame (meso level) as a primary domain of interaction and other external domains of interaction (micro and macro levels) aims to highlight to the reader that actions and information could go from the laboratory to an external domain and vice versa. It attempts to demonstrate how participants are connected to multiple sites during the implementation of their scientific responsibilities and how other external sites remained linked to the laboratory affecting the information practices of scientists. Using the language of magnification and frames, the frame can be adjusted based on the participants' accounts, to go from and to the meso level, to a greater level of magnification, or to a lower level of magnification, to move with the scientists to different domains.

The idea of the Domains of Interactions is used here to differentiate between the laboratory and other sites or domains. It also allows the researcher to focus attention on whether the scientist is at the centre or the periphery of action and control. At the bench, we saw the scientist in control of the activity, zooming in and working with the microscope, we saw the negotiation or tussle with the bacteria, and zooming out, we saw how the scientist has little control over employment conditions, eligibility for grants or immigration status, and is at the periphery in these domains.

In summary, Schatzki's (2016) arguments in favour of flat ontology are based on the redundancy of expressing the social in larger scales, when everything can be explained in terms of local practices, without the need to resort to larger scopes, which are ultimately a larger dimension of the site, and such larger dimensions can be explained in terms of slices (Schatzki, 2016, p.36). Latour rather prefers to "localise the global" by bringing attention to the associations; this will allow one, according to Latour, to draw more accurate maps by exposing the detail of the associations and interactions needed to analyse a network (Latour, 2005, p.165). However, the Cosmic Zoom and the concept of Domains of Interactions have afforded the exploration of multi-faceted information practices of laboratory-based scientists, by following the traces of participants' accounts and bringing together the complex set of domains, actors which impact the information practices as they go about their scientific work, and the construction of knowledge. Without the use of this analytical tool, this concept of Domains of Interaction would not have emerged. The analytical tool is particularly useful in research in information practices, because as McKenzie (2003) encourages, it enables researchers to take into consideration factors beyond a localised focus, making use of the interactions and relationships that people face in their everyday lives.

An Innovative Approach to Methodology

The implementation of ethnography as the methodological approach is not common in information practices research. Thus, its use in this study opened

opportunities for other innovations that make a contribution to research in information practices. This section introduces the contribution made to the writing of ethnographic findings, including choice of voice, the use of vignettes in presenting findings and the adoption of a literary style, marvellous realism, in the writing of these vignettes.

On Writing Ethnographic Accounts

An important contribution of this study to the Information Practices research is related to the interpretative capacity of the ethnographer to represent the culture to diverse audiences via written accounts. I discuss my approach to the writing of ethnography in this study. I begin with a reflexion on the positionality of the social researcher as ethnographer, and how the different positions assumed by the researcher as ethnographer in the process of observation are mirrored in the written accounts, something that is important as a matter of methodological transparency. This is an important point, as ethnographic accounts are an integral part of the methodology, however, in many cases, research that claims ethnography as a methodology could be limited to interviews (Zhong & Han, 2022)

The following section discusses the use of stories or vignettes as the selected format to present the findings, and the merits of such choice as a contribution to the larger field of knowledge. The final section presents the use of Marvellous Realism as a literary style used for writing the vignettes, considers its suitability with an ethnographic approach and its compatibility with the analytical tool of the Cosmic Zoom, as a mechanism to use the descriptive narrative to elucidate hidden domains of interaction.

Using Two Voices and Expressing the Ethnographer's Positions

The present study makes a methodological contribution by proposing the use of dual voices in the ethnographic accounts, where the first and the third person voices are interwoven in the writing of vignettes. The use of this polyphony in the findings is meant to present the distinct discourses as complementary

(Bakhtin, 1981, p.259), ensuring the voices of participants are heard, but that the voice of the researcher as a participant is not silenced. In this investigation the use of the third-person voice indicates my role as a social researcher, trying to take a prudent distance to evaluate with rigour the information practices of a group of scientists within the context of the laboratory (Van Maanen, 2011, p.7). I have also employed the first-person voice that recognises my firsthand impressions as an observer, acknowledging that my presence was not neutral, nor were my observations or interpretations unaffected by the interactions with participants and the environment in general, as if I were an omnipresent “eye”, rather than a fully present “I” (Haraway, 1988, p.581; Clifford & Marcus, 1986, p.10; Gherardi, 2019, p.741).

The use of the dual voice in ethnographic accounts is an appropriate approach, one that should be considered by other researchers in Information Practices applying ethnography as a methodological approach. It is rare to find the transparency (Behar, 1996) that such an approach allows in many reports of ethnographic research in information practices. The positionality of the ethnographer as a tool of enquiry is something that must be made evident as a critical factor of interpretation and data collection, and it emerged organically in this study. This was without a doubt because of a point of deep reflexion through my own use of the ethnographic method, however, it was progressively cemented as an apt choice, supported by the work of ethnographers that have reflected on the reflexive and interpretative turn in ethnography, especially Geertz (1973), Clifford and Marcus (1986), and Behar (1996).

I found no useful examples in information practices research of how to present these two aspects of the researcher. The works of Latour and Woolgar (1986), or Knorr-Cetina (1999) served as examples of how to do it for me, although I did not adopt either approach. Nonetheless, consideration of how to present these two aspects of the researcher gave me some insights into how to reflect on my interactions with the participants and to obtain an appropriate understanding and interpretation of the social environment. It also allowed me to create a self-reflexive space while struggling to make sense of the culture’s meanings and

social dynamics I was witnessing. Latour and Woolgar (1986) in their seminal work *Laboratory Life* opted for using the figure of the “observer” in the third person, in order to detail some of the experiences they went through when entering into a foreign social environment with its own cultural particularities (Latour & Woolgar, 1986, p.17). The character of the observer serves as a proxy for them to take distance as social researchers, while at the same time, it gives them an opportunity of being able to capture some of their firsthand impressions, doubts and self-reflexions as social researchers, all however narrated in the third voice. On the other hand, Knorr-Cetina’s (1999) takes a different approach. Her investigation uses various ethnographers at each site, with the report of the investigation structured as first-hand accounts of ethnographic observations, with scattered quotes from participants when relevant.

In summary, this study proposes that the use of a confessional and reflexive voice, alongside with the realist tone is not only methodologically acceptable (Bourdieu 2003, p.282), but even desirable and ethical (Behar, 1996), to demystify the researcher’s position as a someone who can observe without affecting the environment (Haraway, 1988, p.581), and to also make evident the process of building knowledge by interaction, relationships and continuous feedback and affectation. Other researchers in Information Practices, could benefit by adopting ethnography as a method to draw insight by directly participating in the environment, and furthermore, by implementing a hybrid approach to make manifest and evident the implication of participating in the site of observation and how such participation affects the ethnographer’s interpretations (Van Maanen, 2011). Such an approach would not only lead to a more nuanced set of findings, but it would also ensure a more ethical approach to the representation of the culture and information practices of the group being studied (Behar, 1996).

The Role of Vignettes in Cross-Cultural Representation

The use of vignettes to present the findings has not been used in research in

information practices as far as I am aware, and certainly not in studies of scientists. I was influenced by Van Maanen's (1995) essay *Style as Theory*, which suggests that every style, including those that present themselves as "neutral", authoritative and detached, do have a rhetorical goal, which is to communicate something about the researchers' assumptions and intentions, namely his or her authoritative and objective pre-suppositions around his or her own positionality within the ethnographic research (Van Maanen, 1995, p.134). From this, I understood that inherent in the writing of the report of a research study, such as this thesis, is an expression of some aspect of the theoretical position of the researcher.

Therefore, in this investigation, the use of the dual voice, along with the use of vignettes to present the findings, is in reality a choice, based on a theoretical position, congruent with the researcher's understanding about the roles assumed through the use of the ethnographic method. And thus, it follows that the writing of the findings of this study calls into question the dogmatic claim that using realist tales is the only way to represent reality, provide knowledge and communicate findings (Van Maanen, 1995, p.134; 2011, p.28). The torrent of experiential knowledge that comes from immersing oneself into others' social dynamics and meanings (Geertz, 1973) and the interpretative power to represent others using words and language, call for more freedom to choose styles that are congruent with the ethnographer's position and roles and that allow the researcher to disclose himself or herself as a participant, not just as an observer (Clifford & Marcus, 1986, p.12; Haraway, 1991, p.81).

Taking an approach which is not found in reports of information practices of scientists or professional groups, (as far as my searches found), this study uses vignettes to report the findings. These integrate Van Maanen's (2011) realist and his confessional tales, using the corresponding third- and first-person voices as explained above. Although I use the more traditional, scientific account in part, the use of what are effectively short stories emerged as I attempted to balance my participation as a social researcher and a "tool of enquiry" imbued with the context. As I practised the writing, what started as a

strong tension between my two positions became complementary (Bakhtin, 1981) in the vignettes, establishing a dialogue between the two voices that settled themselves as aspects of my experience as an ethnographer. This experience, particularly the importance of acknowledging that “I” was there, showed me that the interpretative prism by which the impressions of the culture are finally forged comes from a kind of collaborative process between myself and the culture of the scientists (Latour, 1984). In this way, I attempted to create a snapshot of the culture at a particular time (Haraway, 1988; Knorr-Cetina, 1999). Although the writing of Van Maanen (1995, 2011) was extremely useful in helping me to decide on the principles to apply in the writing, I found no appropriate examples to guide me, and although I read of the struggles of Latour and Woolgar’s “observer”, they were written in the third person, again creating a distance between writer and reader.

Such a representational privilege (Geertz, 1973; Clifford & Marcus, 1986) to tell the story and bring the findings of a culture at a particular time, requires of the social researcher to not only be there and to interact with the culture (Behar, 1996; Bourdieu, 2003) but to think about how to better represent the culture and the interpretative flavour in the ethnographic accounts. Should these accounts be communicated only via the dry and clinical text of the realist style? Is it that or nothing else? Or is there any latitude to bring out the multi-dimensional complexity of an environment subjected to a great number of forces pulling and pushing in all directions from many domains, and to highlight the drama of human interaction, via other styles? These are questions I confronted.

The vignettes acknowledge this privilege, providing the researcher an avenue to reconstruct the social environment and the information practices, by using quotes and descriptive language that allowed me, this researcher, to add texture to the findings and add connective tissue and volume to the context, bringing the reader closer (Erickson, 1985, p.102) to the scientists. Erickson points out that vignettes in ethnographic work provide rich and persuasive descriptions intended to have a rhetorical, analytic and evidential function in the reports (Erickson, 1985, p.103).

Another aspect that is important in the use of vignettes is to highlight those everyday-life dynamics that constitute information practices; they are central to an information practices approach based on an ELIS approach (McKenzie, 2003) and fundamental to the writing of vignettes in an ethnographic study. The advantage is that the power of descriptive language allows the researcher to build greater nuance and display more complexity, as communicated by the participants and the witnessing of the observer. Such an approach establishes the very exercise of writing as a method to bring some hidden dimensions that would, perhaps, be removed from a more scientific method (Richardson, 2003, p.924, Van Maanen, 2011, p.33). It brings the aspect of writing to the centre of the ethnographic methodology, as essential for elucidating the interpretations of other cultures, by using language as a mechanism to build and transmit knowledge.

This thesis, then, stands as a contribution to research in information practices. The use of vignettes supports the demand, in ELIS, for the details of the everyday life, and at the same time, respects the privilege of representing the culture of another group.

The Use of Literary Styles in Ethnographic Accounts

A further innovation in this study is that the vignettes are narrated in a style that is inspired by the use of a literary genre called “Marvellous Realism”, also known in English as “Magical Realism”. This genre originated and is prominent in Latin America literature, (Slemon, 1995, p.9; Camayd-Freixas, 2014, p.3).

The use of a literary style is not foreign to the writing practices of ethnography (Van Maanen, 2011; 1995; Erickson, 1985; Richardson, 2003), even though it is not common in information practices research. Marvellous Realism may seem like an unusual choice, given that in Western scholarship it tends to be considered fanciful. Yet, the great strength of Marvellous Realism, as a writing style, is its ability to use realistic descriptions to evoke the unspoken tales that seem to be obfuscated, as García Márquez observed (Zamora & Faris, 1995, p.4). I have, in a similar vein, used the descriptive power of Marvellous Realism

as a mechanism to unveil hidden, but real aspects that would otherwise be buried under other more technical narratives. Therefore, the vignettes communicate the liveliness of the “marvellous reality” of the scientific culture, as a product of experiencing it and diving into it (Taussig, 1992, p.2).

Thus, this investigation has employed the descriptive richness of Marvellous Realism, as a mechanism to verbalise the complexity of the information practices. It has shown how the scientists experience links from other domains to their everyday realities as scientists (Juschka, 2003, p.93), which, potentially hidden from the normative framing of the work of the scientist, constantly exert an influence on them and their information practices. This was evident from their accounts, as those aspects were not some sort of abnormality, but central to their experience. Therefore, these experiences needed to be made manifest throughout the vignettes as an integral component of the social environment of the scientists.

As stated earlier, it is important to underscore that the use of magical realism does not imply that other domains beyond the laboratory are fanciful or mythological, but that they are beyond the site of observation, yet the findings also show that these domains are not apparent at first sight and only appear through the narratives of the scientists. Nevertheless, they have had a very tangible influence on the scientists and their scientific and information practices. Therefore, the descriptive approach of the vignettes, written in the style of Marvellous Realism, not only recognises these otherwise hidden domains, but brings them to the forefront, as integral parts of the scientists’ experiences and information practices (cf Taussig, 1992, p.109).

Thus, to conclude, this use of a literary style to record my observations (Van Maanen, 1995) has been valuable in presenting the complexity of the scientists’ reality. While Marvellous Realism may not be a literary style that others want to adopt, nonetheless, this study has demonstrated the benefits of using a literary style in the writing of ethnography.

On the Practices of the Ethnographer

The ethnographer becomes a tool of enquiry, immersed in the social context and establishing relationships and rapport by exercising their own personal attributes to make connections, understand meanings and interpret the social context (Geertz, 1973; Behar, 1996). This process calls for an appreciation of the different roles the social researcher assumes during participant observation, the need to be the rigorous observer, the importance of building rapport to enlist participants and to draw information from them, and significance of being aware of the effect that fieldwork has on him or her. This process brings a reflexive flair to the accounts, that rather than being narcissistic (Bourdieu, 2003, p.287), is methodologically honest, as it brings to the table of scientific enquiry, the biases, struggles and influences under which the ethnographic accounts have been written (Behar, 1996), as discussed above in the section “Using Two Voices and Expressing the Ethnographer’s Positions”.

In this final section, I reflect on the roles of the ethnographer and my developing understanding of them. As a doctoral student I began to learn about ethnography from reading textbooks on research methodology and examples of ethnographic studies, both the classics in the field and in information practices. Textbooks on ethnography discuss the need and requirements for immersion into a foreign culture for observation and establishing trust with participants (Faubion, 2001, p.51; Mason, 2002; Ritchie & Lewis, 2003, p.75; Flick, 2009, p.169; Emmerson et al., 2011; Bryman, 2012). Through their technical and authoritative disposition, some tend to implicitly assume the observer as a neutral figure, or present a dispassionate account of the logistics of getting access to the environment, without disclosing the importance of interpersonal relationships, dramas, thoughts and details that are inevitable for the researcher as he or she undertakes participant observation, especially during the early immersive period into the new culture (Van Maanen, 2011, p.45).

However, authors such as Geertz (1973), Clifford and Marcus (1986), Behar (1996) and Taussig (2010, p. xi-xii) pointed out that diving into a foreign culture

and getting imbued with its social dynamics requires the ethnographer to be there, to establish points of commonality with the culture and its participants, to be vulnerable, in order to be able to not only extract information, but interpret observations, meanings and intentions behind the acts the social researcher is witnessing. I learned also that the reflexivity of the ethnographer, and the acknowledgement of the struggles of the research process, were essential to the research process (Rosaldo, 1986, p. 92; Erickson, 2018, pp. 100-101).

During the development and implementation of the ethnographic method, I was confronted with the tension between being a rigorous scientist and the need for closeness while establishing relationships and building rapport with participants, to draw out information and create knowledge. It was undeniable that I was participating cognitively, physically and emotionally in the site of observation, and my inclination was that this tension that I felt between my different roles and positions needed to come through in some way, as an integral part of my ethnographic method (Geertz, 1973, p.5; Bakhtin, 1981; Clifford & Marcus, 1986, p.2). From what I had read, and from my own understanding, this appeared to be not only methodologically sound but honest (Behar, 1996, p.13), to acknowledge that I was responsible for observations in the environment and for the interpretative perspective by which meanings and social dynamics were given significance (Geertz, 1973, p.5).

At the same time, I observed that my experience was congruent with the Latourian philosophical position, which tell us that actors reveal themselves through relationships (Latour, 2005; Harman, 2009, p.75; Harman, 2018, p.47), and that such relationships are transformative of information and knowledge. This insight pushed me closer to Van Maanen's (2011) confessional tales, in my writing of some of the findings, not as a totalising effect on the ethnographic accounts, but as hybrid approach of the need to represent both the realist's authoritative voice (Van Maanen, 2011, p45) and the more reflexive tone that accepts the effect of the research processes on the social observer as a tool of enquiry.

In deciding how to approach the writing, I could have adopted the approach used by Latour and Woolgar (1986), but I thought that such an artefact was unnecessary, and since I was the one experiencing these emotions and struggles and participating in the foreign context, it would be methodologically transparent to be able to make these aspects known to the reader. Once again, my reading showed me that this dual position and the inclusion of the reflexive tone advocated by authors such as Geertz (1973) and Clifford and Marcus (1986) makes the reflexive tone a methodological necessity and an ethical act of transparency (Behar, 1996; Taussig, 2010, p. xi).

As an ethnographer, some personal characteristics had a clear role to play in the way I was able to implement the ethnographic method. One of these characteristics was my condition as an immigrant. As several of the scientists were also immigrants, this could enable me to be seen as an ally at times, for instance in conversations during breaks over lunch in the social area. The point of having commonalities as bridges to establish common ground and gain trust is not a matter of special pleading made by a new researcher. We can observe such claims in well-established literature on ethnography (cf Geertz, 1973, p. 416; Clifford & Marcus, 1986, p.107). What this type of happening highlighted was the ability to relate as human beings, trying to make a living and studying in a different country far from our family and mother culture. These personal characteristics can have a profound impact on the way relationships are established, rapport is built, and trust is gained, which is difficult to measure; they permit the researcher to get a degree closer to participants, leaving aside some of the suspicions that an external observer could face at the beginning (Van Maanen, 2011, p.7; Bryman, 2012, p.492; Denzin & Lincoln, 2018, p.1017).

Textbooks refer to the importance of preparation, without necessarily giving examples. The level of preparation I carried out before meetings with the leader of the laboratory, the group as a whole and each of the participants was important in establishing my credibility as a researcher and gaining trust from my participants. As an overall strategy, I made it a priority to read their papers,

listen to media interviews and follow their social media. As much as possible, I wanted to “learn their language” and minimise the gap between myself and them. This strategy provided me with background knowledge and a vocabulary to be able connect with them by beginning with their own research whenever possible, as an entry point for further conversations about their work as scientists.

As my time in the laboratory, observing and interviewing the scientists taking part, the preparation became part of my practice as a researcher, no longer a task required of a doctoral student. This preparatory work, a form of observation in its own right, was important for this investigation, giving me background knowledge on the research focus for each scientist, as well as an understanding of the overall mission of the laboratory. This is not to say that other researchers do not undertake preparatory work. Haider and Kjellberg (2016), for example, indicate that documentation was collected via the website from the groups and institutions participating in their research, and from Bryman’s (2012) examples, we can see that researchers prepare the artefacts for their investigations, but here, I made a special commitment to interact with their academic papers, articles and interviews, so as to try to understand their discourse and research and to generate questions that could spark conversations.

I have so far reflected on some of those experiences that are only gathered through immersion into somebody else’s social environment, trying to observe and also understand, trying to be there but not to be obtrusive, and to document experiences ethically. As mentioned before, Behar (1996) states, the exercise of “Participant Observation” is paradoxical, one is asked to be neutral, but at the same time the researcher needs to make connections and be engaged to move forward. The doctoral student develops as an independent researcher through reading and through all these experiences, that emerge as a way of learning through the processes of interacting with other humans to collect data and reflecting on the implications of being given access and having the privilege of representing another culture with honesty and respect.

The following section brings together the major themes discussed in this chapter, providing some concluding remarks and highlighting the most important aspects of this chapter, before moving to the final chapter of the study.

Conclusion

This chapter discussed the findings of the present study and its contributions to Information Practices. It began by discussing the contributions this study makes to Information Practices. It presented the epistemic culture of this group, showing its key features using Knorr-Cetina's conceptual frame and then the salient features of the local culture of this group. Then, it examined the major empirical findings in the areas of information use and knowledge creation, embodiment and affect. In doing so, it considered how the study's findings could be compared with contemporary literature in information practices. The second section of the chapter presented the innovative approach to research in information practices used in this study that emerged through the development of the analytical tool of the Cosmic Zoom. The use of this tool revealed the multiple interactions that actors may have within other sites and led to the emergence of a new concept, Domains of Interaction. The emergence of this concept permitted me to rethink Latour's flat ontology and Schatzki's concept of site. The third section discussed the innovative approaches to the writing of the ethnographic accounts. The writing exemplifies the two positions of the ethnographer through its use of first- and third-person voices, in its attempt to represent the culture of the scientists. This section discussed the choice of the use of vignettes, as a way to present information practices within their social context and the adoption of the literary style of Marvellous Realism for writing the vignettes. The chapter concluded with a discussion of what it means to be an ethnographer, highlighting the importance of bringing together readings from the literature on ethnography and my experiences, and how I enacted my roles as ethnographer, through the research.

The following chapter, Conclusion, will bring together the main aspects of the present study. The chapter summarises the research, highlighting the main

contributions and implications for Information Practices, as well as noting the limitations of the study.

CHAPTER 6: CONCLUSION

Introduction

This chapter presents the conclusions derived from this study and its implications for further research and for professional practice. It begins with a summary of the study as a springboard to discuss the major contributions made by this study to research in Information Practices. The chapter then presents some topics for further research related to methodology and to Information Practices. The subsequent section indicates some of the implications of the findings of this study for professional practice in Information Management. The chapter ends with a brief statement of the limitations of the present study and some concluding remarks.

Summarising the Study

This study explored the question: **What are the information practices of a group of scientists working in a university laboratory?** The ethnographic study was carried out at a laboratory in a university in NSW between August 2018 and July 2019, following six of the nine scientists in the laboratory across their experiments, microscopy sessions and interactions with them via semi-structured interviews, and observations sessions in the laboratory. The ethnographic approach also included analyses of media interviews, press releases, and readings of the scientific papers written by members of the group. This study recognises information practices as a suitable perspective to understand how information is created, used, and shared as an expression of social practices, in order to construct the authoritative scientific knowledge that ultimately is represented through academic papers.

The study draws on the literature of information practices and is influenced by the conceptual work of Savolainen (1995), Savolainen and Thomson (2022) and

McKenzie (2003), as well as by the studies introducing embodiment and affect into information practices by Lloyd (2007) and Olsson (2016).

Mindful of the criticism that many studies of Information Behaviour and information practices are atheoretical (Pilerot & Ekström, 2025), this study used the conceptual frame of Practice Theory, supported by Actor Network Theory. The adoption of a Schatzkian Practice Theory approach provided a frame to view information practices as an established set of activities in an environment whose participants share common understandings and rules. The use of Latour's Actor Network Theory allowed for the inclusion of both human and non-human actors belonging to the social context, and consideration of the movement between them.

The research contributes to the broader literature of Information Science by studying scientists during the performance of their scientific activities, while producing new knowledge at the laboratory. It steps aside from the normative research on information needs and seeking behaviour to understand their information practices during their typical activities, adding a study to an area where there has been found to be a lack of research (Huvila & Gorichanaz, 2025). Therefore, and to build a background with research on scientists in the laboratory, this study sought to go outside the literature of Information Science to bring in ideas relevant to the study of the information practices of laboratory-based scientists. Thus, the work of Latour and Woolgar (1986), Knorr-Cetina (1999), Pickering (1984; 1995) and Horton (2021) was drawn from the literature of Science and Technology Studies (STS). As Peerbaye and Vinck (2025) have concluded, this type of research has decreased after the seminal work of Latour and Woolgar (1986) and Knorr-Cetina (1999). Nonetheless, in a broader sense, research in Information Practices can benefit from a greater understanding of the interactions with technology within scientific settings, thus contributing to an area of research not greatly explored in recent years within Information Science (Van House, 2004; Huizing & Cavanagh, 2011; Pilerot et al, 2017).

The ethnographic methodology draws on the influential work of Geertz (1973), among others, in emphasising the importance of representing the culture under examination clearly, while acknowledging the significance of the positionality of the researcher in the interpretation of observations. The ethnographic writing, informed by Van Maanen (2011), recognises the importance of this acknowledgement to ensure an ethical approach to the report of the findings.

The findings of the study, written in part as vignettes, present the information practices of the scientists in their social context. They identify the ways the scientists use information and focus on key aspects of the information practices within their social context.

The study has contributed to research in information practices in several ways, beyond adding to the small number of laboratory-based studies. By using the work of scholars from STS, it has demonstrated the opportunities for cross-pollination from a field with similar concerns and perspectives, albeit with a different focus.

The significance of a local culture in the meanings given to an information practice, as Knorr-Cetina had proposed through her concept of epistemic cultures, emerges here, but this local culture is not the narrow, localised, approach found in much of the research in information practices. Rather, the understanding of the local culture reveals the rich texture of information practices, in the way that McKenzie encourages (2003).

The use of ANT is not common in studies in Information Practices and this adoption of it is something of an innovation. This approach allowed me to include non-human actors such as the microscope and bacteria and also to include other factors such as the visa regime for scientists from overseas and visa status as having a degree of influence over the information practices of these scientists. I also adopted Latour's methodological advice to follow the actors where they go and to let them describe the social context as experts in their own world (Latour, 2005). Following this advice led me to challenge Latour's position, also held by Schatzki, that social environments should be

understood as the unfolding of actors and practices in one plane of agency or a flat ontology. This led to the development of the analytical tool of Cosmic Zoom and the emergence of the concept of Domains of Interaction.

This analytical tool, the Cosmic Zoom, with its emphasis on magnification and the agency of the actor, and inspired by Horton's (2021) Cosmic Zoom, enabled me to see that the scientists moved from the laboratory to other sites as they talked about their work. They were not engaged in relationships in a single plane but could move between planes. This indicated the need to replace the notion of the flat ontology. As a consequence, I saw the need for a new concept, and I have labelled these places of engagement Domains of Interaction.

A further contribution is the use of ethnography as a methodological approach for Information Practices research in a scientific laboratory. This methodological approach permits the researcher to become an insider and an outsider to the social context, something that is made explicit through the findings and discussion in the shape of a dual voice. This twofold position is displayed through the ethnographic accounts in an intertwined third- and first-person voice, in which the I captured my observations as a social investigator, but also my impressions as a participant in the context for a limited period of time. This made evident that as a social researcher, I was a tool of inquiry within the site, and the recognition of this in the study is an acknowledgement of my ethical concern with transparency in the research process.

The writing of the ethnographic accounts that allow me to present my findings follows Van Maanen (2011) and his realist accounts to present the observations in written form. This in itself is not an innovation, nor is the use of vignettes in the writing of ethnographic accounts. Van Maanen (2011) encouraged freedom in the writing of ethnographic accounts. However, this investigation makes a contribution to the way findings are presented in information practices not only in the use of vignettes, but by using the literary style of Marvellous Realism. The adoption of the literary style of the Colombian novelist, Gabriel García Márquez,

with its emphasis on descriptive detail that enables aspects below the surface to emerge, facilitated the development of more complex descriptions of practices.

A final contribution comes through a re-assessment of what these scientists consider their role in the system of science. Latour and Woolgar (1986) concluded that the scientists in their study were in the business of writing academic papers, and while there is emphasis from the scientists in this study that writing academic papers is a very important outcome of their work, nonetheless, it is clear that they are in the business of constructing stories. Therefore, storytelling and cohesion, not only of the facts, but in how such facts have a common thread that unites them in a narrative, seems to be important for scientists when making sense of their findings.

Implications for Further Research

The outcomes of this study suggest a number of avenues for further research. An obvious suggestion is to encourage more research on information practices in scientific laboratories, to advance understanding about how different groups enact information practices. Further research could take advantage of ANT as a viable conceptual framework within Information Science to elucidate the types of relationship that human actors establish with non-human actors, and how the social dynamics of the relationship can contribute to information practices. In what follows, I propose five areas where this study has identified interesting areas for further development, across methodological and conceptual aspects.

On Methodology

The Researcher Positionality

There is scope for research and writing on the positionality of the researcher, beyond the brief statements found in textbooks on ethnographic research. Studies of research methodology rarely focus on the details and implications of researcher positionality, even though it is critical to understanding the researcher's effects on research outcomes. I have been interested in how the

researcher becomes a tool of inquiry in the ethnographic approach and I have highlighted that my own immersion within the scientific culture of the laboratory affected the data I collected. I have explained how I took on a dual position, one of a rigorous social researcher trying to maintain a distance from the social dynamics, in order to observe and capture the salient aspects of the culture and its practices, but also the human person that was trying to build rapport, establishing bridges and commonalities to facilitate relationships and elicit information. My positionality also emerged naturally through the ethnographic accounts, bouncing organically between the third-person voice of the social researcher, and the first-person voice of the individual. The ethnographic accounts are written using the style of Marvellous Realism, which also emerged as a consequence of my positionality and background. However, I had little guidance from the literature in how to manage my positionality. Accounts of how other researchers managed their positionality would have been helpful in clarifying how to enact being a researcher and thus, I propose this as an area for further research and writing.

Using the Cosmic Zoom Analytical Tool

The use of the Cosmic Zoom as an analytical tool emerged from Horton's (2021) proposal of viewing scales as a mechanism of framing and mediating relationships. This study suggests that the Cosmic Zoom approach can be used in future research to address McKenzie's (2022) and Olsson's (2025) concern that information research needs to go beyond a narrow and localised conception of the site of observation. As this study shows, following actors wherever they go may entail moving with them to domains in different locations beyond the local setting. To that end, the Cosmic Zoom approach developed throughout this investigation affords the ability of expanding the social context to other domains. Further research could help to refine this analytical tool, potentially identifying other ways in which social interactions are not anchored to a single plane of action.

On Information Practices

Embodied Practices

The exploration of embodied practices in the scientific laboratory would broaden the understanding of the knowledge scientists require, both tacit and explicit. Preparations for scientific work, as described in the academic literature, are presented, mostly, as intellectual, focussing on the information behaviours leading to the development of hypotheses and then the writing of academic papers. Yet, this study has demonstrated the significance of embodied learning for information practices within the laboratory, including through the recognition of particular smells, the ability to “stab” into the Petrie dish, or the capacity to work in the physically constrained space of the laboratory bench. The scientists in this study did not seem to acknowledge that some of their information practices were based on embodied learning. One participant referred to the ability to work at the bench as “common sense”, without which an individual could not be successful as a scientist, as this was fundamental to practices in the laboratory. Research focussing on embodied information practices in the scientific laboratory could shed light on under-researched aspects of scientific expertise.

The Role of Storytelling in the Construction of Knowledge

There is scope for further research into the ways scientists develop and present the arguments in papers they write for publication. This study identified that academic papers are not necessarily developed in the ways demonstrated by Latour and Woolgar (1986), but that scientists attempt to thread a story that evolves from the first tentative statement of hypothesis to the final academic papers that encapsulates authoritative knowledge. We have come to accept the scientific and objectivist approaches that portray the coalescence of knowledge in academic papers as the product of the scientific method. However, this study challenges this assumption in a number of ways. It shows that the production of academic papers is more than the application of the scientific method, that there is a story that is shaped by the interaction with non-

human agents and external factors in Domains of Interaction. Further research into the ways scientists conceptualise their process of writing academic papers could shed light on the ways in which the concept of storytelling informs this aspect of the information practices of scientists.

Further investigation on the role of stories during the construction of knowledge in the laboratory could be important to demonstrate that knowledge is not only the accumulation of facts, but that there is a narrative to which multiple actors, including non-human actors, make contributions, and that is the result of scientist's interaction with their environment, technology as well as their subject of investigation. This prompts further questions about the conditions for completeness and acceptance of the final story. All these questions could be further clarified in more detailed studies about the role of storytelling in the construction of knowledge, especially among scientists.

The Influence of an Ontological Approach

One of the interesting findings from this study was the localised flavour with which this group of scientists implemented the practice of observation. Professor Karen introduced me to Van Leeuwenhoek's first principle, love for simply observing the world, which I observed as a key principle in the research practices of her team. They expressed their love for microscopy as the focal point of their investigations, and their self-reported love for observing the bacteria's behaviour seemed to distance them from observation practices used in other laboratories. Professor Karen's acceptance of a particular ontological position, deriving from the concept I have referred to as Echoform, also clearly influenced the team members. Further research could be used to determine how ontological positions are expressed by scientists in a given laboratory and to what extent information practices in those research environments are the consequence of the scientists' ontological positions, as they would seem to be here.

Implications for Professional Practice

As described at the beginning of the thesis, I am an information practitioner in the field of Information Management and I work with a team of consultants in the field of Intelligent Information Management (IIM), which assists organisations in all sectors to understand their information ecosystems, information needs and to design and implement information solutions and strategies that can help businesses to increase their information maturity. Through my almost 20 years of experience in the field, I have seen a widespread focus on simply implementing technology as the only solution to the information needs of an organisation, or as a reaction to external pressures such as legislation, including Records Management legislation, compliance and privacy laws or industry trends such as Big Data, Analytics, or AI, rather than a conscious effort to understand the information context and the multiple internal and external factors that shape information practices and the design of information roadmaps.

The contrast of the findings coming out of this research with the generally held beliefs in the profession as I know it, highlights the myopic vision with which information and knowledge landscapes within an organisation are understood and how information solutions are designed. For the most part, these follow a traditional cognitive viewpoint that understands information simply as the intellectual output of human agents, and taxonomical structures tend to be based on old metaphors inherited from the age of paper records held in basements, folders and boxes. These traditional, even archaic, views have become an obstacle for organisations to manage their information, which has been sometimes characterised as the sap or blood of an organisation. Information is conceptualised as energising and enabling relationships and business processes to move forward, but the organisation's information practices constrained by such metaphors break down at the individual level. When they become a hurdle to individuals doing their daily tasks, users end up circumventing information structures or policies in pursuit of their efficiency.

In this study, the findings indicate that information practices are complex processes that involve multiple actors and circumstances. They are constituted from common implicit and explicit rules and circumscribed through affective structures that give cohesion to the social context and organisation. The research process itself can contribute to business practices. One could conclude that projects for the implementation of information solutions should not be constrained only by gathering requirements for the implementation of technology, but that they should also include within the phase of analysis and design a sufficient interaction with the stakeholders to understand the drivers and circumstantial context that make the organisation unique, identifying the key features of its epistemic culture. Integral to the analysis of the environment is a description of the social context and understanding of how human agents interact with other actors and technologies, including their affective and emotive factors. Inclusion of these factors can help to build a more realistic picture of the information practices of an organisation and how an information solution can integrate with such practices in a more holistic way. These factors can then be translated into technological requirements to address the information needs of the users in the organisation.

Another important implication for the greater scope of business practices is the application of the findings and conclusions to the rise of emergent technologies such as artificial intelligence (AI), machine learning (ML), and large language models (LLM), which have a different nature from traditional trends and technologies. These new generative tools not only allow analysis and classification of information, but they have the ability to assimilate content and generate new content independently, albeit based on algorithms and a priori data. These new emerging technologies allow for managing information processes independently of human intervention and can work alongside human agents to assist in many of their tasks. These technologies can also assist with automation, by leaving repetitive processes to be managed by these technologies.

In this study, we can see scientists working with non-human actors, such as the bacteria and the microscope, and how they are impacted by the way those non-human actors react to their inputs and triggers. We can note how the scientists anthropomorphise and personify these objects and reclassify them as participants within their own practice. Information professionals, like those in my team, are already using the findings of this study to move away from the traditional views of the relationships with technologies, to acknowledge that the technologies they work with can be seen as collaborators and participants in the information process.

Such a realisation can be extrapolated to emergent technologies today, as we see them managing information tasks and assisting human agents to achieve their outcomes. This independent participation recognises a degree of agency for such tools, as seen in this investigation in the case of the microscope and the bacteria. In many cases the tools are designed to have conversational interactions with human-agents. It is already possible to think that these tools can be anthropomorphised with actual identities. Many of these tools, now referred as “agentic”, participate in information processes as virtual workers, so that they could be assigned roles and responsibilities within the information landscape. Human workers could converse with such tools and inquire about the status of their tasks, their progress and other aspects of documents within repositories, and interact with the non-human “digital workers”, as collaborators within the information processes of the business. The findings of this study show how such a collaborative relationship can be established, and Pickering’s metaphor of the dance of agency applied in the study demonstrates how both humans and non-humans must make adjustments for the collaborations to be fully effective.

Study Limitations

The study focuses on a relatively small group of scientists from a single laboratory who agreed to participate in this investigation. The investigation was approved on the condition that participants willingly agreed to participate and

that the identity of the laboratory and of the scientists was not revealed. The small number of participants could be seen as a limitation, as it was not possible to interact with the whole team of scientists working in the laboratory, only with those (six out of nine) who agreed to participate. A further limitation might be seen in the approach to data collection, given the relatively short time (interactions over the course of a year), comparatively speaking, I was able to spend in observation and interviews. This study did not enjoy unlimited access to all scientists as did other comparable studies, such as the studies of Latour and Woolgar (1986) and Knorr-Cetina (1999), which had access to greater numbers of scientists, nor as in the case of Knorr-Cetina's study, was it performed across various laboratories for a longer period of time. Nonetheless, the richness of the data collected enabled a wealth of findings to be recounted and sound conclusions to be drawn.

Concluding Remarks

This innovative ethnographic study explored the information practices of a group of scientists working in a laboratory at a university in NSW, Australia. The richness of the data showcased their information practices as enacted during the course of the investigations. The study is significant for several reasons. It contributes to the scarce number of studies focusing on scientists working in a laboratory. In doing so, this research has an interdisciplinary approach, connecting with STS literature and using the seminal work of Latour and Woolgar (1986) and Knorr-Cetina (1999), which still remain as the most significant examples of ethnographic studies in scientific laboratories. The use of ethnography as a research methodology emphasising a broad approach to the data collected, and the acknowledgement of the importance of the approach to writing the ethnographic accounts, are also noteworthy, as is the concern with the role of the ethnographer.

The findings themselves are significant for two reasons. Firstly, they showed how this group of scientists have elaborated their own epistemic culture and bring to light how information practices may be expressions of broader

influences, coming, in this case, from the approach to scientific exploration espoused by the group's leader. Secondly, they bring a focus on ELIS as an important aspect of the information practices in the lives of the scientists.

The study is also significant because of the use of Schatzki's practice theoretical approach, and of concepts from other studies, particularly from Latour's ANT, which led to the development of the analytical tool of the Cosmic Zoom and the concept of Domains of Interaction, which have extended the range and complexity of the social space beyond the site of observation. Finally, the study is significant because the findings are not only relevant to research in Information Practices, but because they have implications for professional practice in Information Management and have already contributed to my own professional practice.

BIBLIOGRAPHY

- Atkinson, P., & Hammersley, M. (1994). Ethnography and participant observation. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Handbook of qualitative research*, (pp. 248-261). Sage Publications.
- Atkinson, P., Coffey, A., Delamont, S., Lofland, J., & Lofland, L. (Eds), (2001). *Handbook of ethnography*. Sage Publications.
- Australia New Zealand Standards. (2010). *Safety in laboratories - Microbiological safety and containment* (AS/NZS 2243.3:2022). <https://www.saiglobal.com/>
- Bakhtin, M. (1981). Discourse in the novel (M. Holquist, & C. Emerson, Trans.). In M. Holquist (Ed.), *The dialogic imagination* (pp. 259–422). University of Texas Press.
- Bautista, G. (1991). El realismo mágico: Historiografía y características [Magical realism: Historiography and characteristics]. *Verba Hispanica*, 1(1), 19-25. <https://doi.org/10.4312/vh.1.1.19-25>
- Behar, R. (1996). *The vulnerable observer: Anthropology that breaks your heart*. Beacon Press.
- Belkin, N. J., Oddy, R. N., & Brooks, H. M. (1982). ASK for Information Retrieval: Part I. Background and theory. *Journal of Documentation*, 38(2), 61-71. <https://doi.org/10.1108/eb026722>
- Belkin, N. J. (1990). The cognitive viewpoint in information science. *Journal of Information Science*, 16(1), 11-15.
- Ben-Jacob, E. (2008). Social behavior of bacteria: from physics to complex organization. *The European Physical Journal B*, 65(3), 315-322.
- Bourdieu, P. (2003). Participant objectivation. *Journal of the Royal Anthropological Institute*, 9(2), 281-294.
- Bourdieu, P. (2004). *Science of science and reflexivity*. University of Chicago Press.
- Brandt, C. (2005). Genetic code, text, and scripture: Metaphors and narration in German molecular biology. *Science in Context*, 18(4), 629-648.
- Bryant, L. R. (2018). *The democracy of objects*. Studium Publishing.
- Bryman, A. (2012). *Social research methods*. Oxford University Press.
- Buckland, M. K. (1991). Information as thing. *Journal of the American Society for Information Science*, 42(5), 351-360.
- Camayd-Freixas, E. (2014). Theories of magical realism. In I. López-Calvo (Ed.). *Critical insights: Magical realism* (pp. 3-17). Salem Press; Grey House Publishing.
- Camayd-Freixas, E. (2020). Primitivism, ethnography and magical realism. In C. Warnes, & K. A. Sasser (Eds.), *Magical realism and literature*, (pp. 30-48). Cambridge University Press. <https://doi.org/10.1017/9781108551601>
- Chen, C. C. (1974). How do scientists meet their information needs. *Special Libraries*, 65(7), 272-280.
- Clifford, J., & Marcus, G. E. (Eds.). (1986). *Writing Culture*. University of California Press.
- Cox, A. M. (2018). Embodied knowledge and sensory information: Theoretical roots and inspirations. *Library Trends*, 66(3), 223-238.

- Cox, A., & Fulton, C. (2022). Geographies of information behaviour: a conceptual exploration. *Journal of Documentation*, 78(4), 745-760.
- Coulter, J. (2005). Human practices and the observability of the 'macro-social'. In T. R. Schatzki, K. Knorr-Cetina, & E. Von Savigny (Eds.). *The practice turn in contemporary theory* (5th ed., pp. 37-49). Routledge.
- Crapanzano, V. (1986). Hermes' dilemma: the masking of subversion in ethnographic description' in J. Clifford and G.E. Marcus (Eds.). *Writing culture: The poetics and politics of ethnography*. University of California Press..
- Devi, K. S., & Lawanda, I. I. (2023). Factors influencing information-seeking behavior of academic scientists in the open access era. *Journal of Electronic Resources Librarianship*, 35(4), 269-289.
- Dervin, B. (1992). From the mind's eye of the user: The sense-making qualitative-quantitative methodology. *Qualitative Research in Information Management*, 9(1), 61-84.
- Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). *The Sage handbook of qualitative research*. Sage Publications.
- Ekström, B. (2024a). *Winding paths to species reports: Information practices in biodiversity citizen science* (Doctoral dissertation, Högskolan i Borås).
- Ekström, B. (2024b). No rose on this one? Citizen science field excursion negotiations at the Great Alvar. *Nordic Journal of Science and Technology Studies*, 12(1).
- Emerson, R. M., Fretz, R. I., & Shaw, L. L. (2011). *Writing ethnographic fieldnotes* (2nd ed.). University of Chicago Press.
- Ellis, D., & Haugan, M. (1997). Modelling the information seeking patterns of engineers and research scientists in an industrial environment. *Journal of Documentation*, 53(4), 384-403.
- Ellis, W. T. (2016). *Information scraps in the smartphone era* (Doctoral dissertation, Virginia Tech).
- Erickson, F. (1985). *Qualitative methods in research on teaching* (pp. 119-62). Institute for Research on Teaching.
- Erickson, F. (2018). A history of qualitative inquiry in social and educational research. *The Sage handbook of qualitative research*, 5, 87-141. Sage Publications.
- Faubion, J. D. (2001). Currents of cultural fieldwork. In P. Atkinson, A. Coffey, S. Delamont, J. Lofland, & L. Lofland, (Eds), (2001). *Handbook of ethnography*. (pp. 39-59). Sage Publications.
- Fetterman, D. M. (2019). *Ethnography: Step-by-step*. Sage Publications.
- Flick, U. (2009). *An introduction to qualitative research*. Sage Publications.
- Geertz, C. (1973). *The interpretation of cultures*. Basic Books.
- Gherardi, S. (2008). Situated knowledge and situated action: What do practice-based studies promise? In D. Barry, & H. Hansen (Eds.). *The handbook of new approaches in management and organization*. (pp. 516-525). Sage Publications.
- Gherardi, S. (2017). One turn... and now another one: Do the turn to practice and the turn to affect have something in common? *Management Learning*, 48(3), 345-358. <https://doi.org/10.1177/1350507616688591>

- Gherardi, S. (2019). Theorizing affective ethnography for organization studies. *Organization*, 26(6), 741-760. <https://doi.org/10.1177/1350508418805285>
- Gleick, J. (2011). *The information: A history, a theory, a flood*. Harper Collins Publisher.
- Gordon, I. D., Chaves, D., Dearborn, D., Hendriks, S., Hutchinson, R., Popovich, C., & White, M. (2022). Information seeking behaviors, attitudes, and choices of academic physicists. *Science & Technology Libraries*, 41(3), 288-318.
- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). Sage Publications.
- Gullbekk, E. (2021). *Performing interdisciplinary knowledge: Information work in emerging interdisciplinary research*. Doctoral dissertation, Oslo Metropolitan University
- Haider, J., & Kjellberg, S. (2016). Data in the making: Temporal aspects in the construction of research data. In J.V. Rekers, & K. Sandell (Eds.), *New Big Science in Focus: Perspectives on ESS and MAX IV* (Vol. 8, pp. 143-163). Lund Studies in Arts and Cultural Sciences, Lunds University.
- Haider, J., & Sundin, O. (2022). *Paradoxes of media and information literacy: The crisis of information*. Taylor & Francis.
- Haines, L. L., Light, J., O'Malley, D., & Delwiche, F. A. (2010). Information-seeking behavior of basic science researchers: Implications for library services. *Journal of the Medical Library Association: JMLA*, 98(1), 73-81.
- Hammersley, M. (2002). Ethnography and realism. The qualitative researcher's companion, (pp. 65-80). Sage Publications.
<https://doi.org/10.4135/9781412986274.n3>
- Hammersley, M., & Atkinson, P. (2019). *Ethnography: Principles in practice*. Routledge.
- Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies*, 14(3), 575-599.
- Haraway, D. J. (1991). *Simians, cyborgs and women: The reinvention of nature*. Routledge.
- Harman, G. (2009). *Prince of networks: Bruno Latour and Metaphysics*. re.press.
- Harman, G. (2018). *Object-oriented ontology: A new theory of everything*. Penguin Random House.
- Hartel, J. (2019). Turn, turn, turn. *Proceedings of CoLIS, the Tenth International Conference on Conceptions of Library and Information Science*, Ljubljana, Slovenia, June 16-19, 2019. *Information Research*, 24(4), paper colis1901.
- Hemminger, B. M., Lu, D., Vaughan, K. T. L., & Adams, S. J. (2007). Information seeking behavior of academic scientists. *Journal of the American Society for Information Science and Technology*, 58(14), 2205-2225.
- Hobbs, D. (2001). Ethnography and the study of deviance. In P. Atkinson, A. Coffey, S. Delamont, J. Lofland, & L. Lofland, (Eds), (2001). *Handbook of ethnography*. (pp. 204-219). Sage Publications.
- Horton, Z. (2021). *The Cosmic Zoom: Scale, Knowledge, and Mediation*. University of Chicago Press.

- Hui, A., Schatzki, T., & Shove, E. (2017). The nexus of practices. *The nexus of practices: Connections, constellations, practitioners*, (98-113). Routledge.
- Huizing, A., & Cavanagh, M. (2011). Planting contemporary practice theory in the garden of information science. *Information Research*, 16(4), paper 497.
- Huttunen, A. (2025). Broadening understanding of affect: A critical review of embodied and social aspects of affect in information behaviour and practices. *CoLIS 2025, 12th international conference on Conceptions of Library and Information Studies*, 60.
<https://strathprints.strath.ac.uk/92915/13/COLIS-2025-Adjunct-Proceedings.pdf>
- Huvila, I. (2008). Information work analysis: an approach to research on information interactions and information behaviour in context. *Information Research: An International Electronic Journal*, 13(3) paper 349.
- Huvila, I., & Gorichanaz, T. (2025). Trends in information behavior research, 2016–2022: An Annual Review of Information Science and Technology (ARIST) paper. *Journal of the Association for Information Science and Technology*, 76(1), 216-237. <https://doi.org/10.1002/asi.2494>
- Igbinovia, M. O., Ogochukwu, E. B., & Igwe, K. N. (2025). Information needs and information-seeking behavior of laboratory technologists in a health-based university in south-east Nigeria. *International Journal of Information Science and Management (IJISM)*, 23(4), 231-248.
- Jablonka, E. (2002). Information: Its interpretation, its inheritance, and its sharing. *Philosophy of science*, 69(4), 578-605.
- Jensen, O. B. (2021). Rethinking scale: Relationality, place and critical zone. in Brandt, E., Markussen, T., Berglund, E., Julier, G., & Linde, P. (Eds.), *Nordic Design Research (NORDES)*, 2021(9), 1-9.
<https://doi.org/10.21606/nordes.2021.1>
- Jirojwong, S., & Wallin, M. (2002). Use of formal and informal methods to gain information among faculty at an Australian regional university. *The Journal of Academic Librarianship*, 28(1-2), 68-73.
- Jones, P. H. (2005). Information practices and cognitive artifacts in scientific research. *Cognition, Technology & Work*, 7(2), 88-100.
- Jones, W., Dinneen, J.D., Capra, R., Diekema, A. R., & Pérez-Quiñones, M. A. (2017). Personal Information Management. In Levine-Clark, M., & McDonald, J. (Eds.), *Encyclopedia of Library and Information Science*, (4th ed. pp. 3584-3605). Taylor & Francis.
- Joubert, M., Davis, L., & Metcalfe, J. (2019). Storytelling: the soul of science communication. *Journal of Science Communication*, 18(5).
- Juschka, D. M. (2003). The writing of ethnography: Magical realism and Michael Taussig. *Journal for Cultural and Religious Theory*, 5(1), 84-105.
- Karamanou, M., Poulakou-Rebelakou, E., Tzetis, M., & Androutsos, G. (2010). Anton van Leeuwenhoek (1632-1723): Father of micromorphology and discoverer of spermatozoa. *Revista Argentina de Microbiologia*, 42(4), 311-314.
- Knorr-Cetina, K. (1981). *The manufacture of knowledge: an essay on the constructivist and contextual nature of science*. Pergamon Press.

- Knorr-Cetina, K. (1999). *Epistemic cultures: How the sciences make knowledge*. Harvard University Press. (2nd ed.). Sage Publications.
- Krippendorff, K. (2004). *Content Analysis: An Introduction to its Methodology* (2nd ed.). Sage Publications.
- Kutschera, U. (2023). Antonie van Leeuwenhoek (1632–1723): Master of fleas and father of microbiology. *Microorganisms*, 11, 1-3. <https://doi.org/10.3390/microorganisms11081994>
- Kvale, S. (1996). *InterViews: An Introduction to qualitative research interviewing*. Sage Publications.
- Kwon, N. (2017). How work positions affect the research activity and information behaviour of laboratory scientists in the research lifecycle: applying activity theory. *Information Research*, 22(1), paper 744.
- Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. University of Chicago Press.
- Latour, B. (1984). The powers of association. *The Sociological Review*, 32 (1), 264-280. <https://doi.org/10.1111/j.1467-954X.1984.tb00115.x>
- Latour, B. (2004). On using ANT for studying information systems: A (somewhat) socratic dialogue. In C. Avgerou, C. Ciborra, & F. Land (Eds.), *The Social Study of Information and Communication Technology: Innovation, Actors, and Contexts* (Online Ed. pp. 62-76). Oxford Academic. <https://doi.org/10.1093/oso/9780199253562.003.0004>
- Latour, B. (2005). *Reassembling the social: An introduction to Actor-Network-Theory*. Oxford University Press.
- Latour, B. (2017). On Actor-Network Theory. A few clarifications plus more than a few complications. *Philosophical Literary Journal Logos*, 27(1), 173-197.
- Latour, B., & Woolgar, S. (1986). *Laboratory life: The construction of scientific facts* (2nd ed.). Princeton University Press. <https://doi.org/10.2307/j.ctt32bbxc>
- Leith, D. V. (2018). *The practice of knowledge sharing: Two environmental sustainability initiatives in Australian Local Government* [Doctoral dissertation, University of Technology Sydney]. <https://opus.lib.uts.edu.au/bitstream/10453/129405/1/02whole.pdf>
- Leith, D. V. (2019). Exploring sensings in practice: Affect and knowledge sharing. *Journal of Documentation*, 75(3), 500-516. <https://doi.org/10.1108/JD-11-2018-0191>
- Lincoln, Y. S., & Guba, E., G. (1985). *Naturalistic Inquiry* (Vol. 75). Sage Publications.
- Lloyd, A. (2006). Information literacy landscapes: An emerging picture. *Journal of Documentation*, 62(5), 570-583. <https://doi.org/10.1108/00220410610688723>
- Lloyd, A. (2007). Learning to put out the red stuff: Becoming information literate through discursive practice. *The Library Quarterly*, 77(2), 181-198.
- Lloyd, A. (2009). Informing practice: Information experiences of ambulance officers in training and on-road practice. *Journal of Documentation*, 65(3), 396-419. <https://doi.org/10.1108/00220410910952401>

- Lloyd, A. (2010). Framing information literacy as information practice: Site Ontology and Practice Theory. *Journal of Documentation*, 66(2), 245-258. <https://doi.org/10.1108/00220411011023643>
- Lloyd, A. (2014). Informed bodies: Does the corporeal experience matter to information literacy practice? In C. Bruce, H. Patridge, H. Davis, & H. Stoodley (Eds.), *Information Experience: Approaches to Theory and Practice*, (pp. 85-99). Emerald Group Publishing Limited.
- Lloyd, A., & Olsson, M. (2019). Untangling the Knot: The information practices of enthusiast car restorers. *Journal of the Association for Information Science and Technology*, 70(12), 1311-1323. <http://doi.org/10.1002/asi.24284>
- Loscher, G., Splitter, V., & Seidl, D. (2019). Theodore Schatzki's practice theory and its implications for organization studies. In S. Clegg & M. P. e Cunha (Eds.), *Management, Organizations and Contemporary Social Theory*, (pp. 115–134). Routledge. <https://doi.org/10.4324/9780429279591-7>.
- Mahon, K., Kemmis, S., Francisco, S., & Lloyd, A. (2017). Introduction: Practice Theory and the theory of practice architectures. In K. Mahon, S. Francisco, & S. Kemmis (Eds), *Exploring Education and Professional Practice*, (pp. 1-30). Springer. <https://doi.org/10.1007/978-981-10-2219-7>
- Malinowski, B. K. (1922). *Argonauts of the Western Pacific: An account of native enterprise and adventure in the archipelagoes of Melanesian New Guinea*. Routledge and Kegan Paul.
- Mansourian, Y. (2022). The passion and pleasure of information sharing in pottery practice. *Information Research*, 27, (Special issue, isic2243). <https://doi.org/10.47989/irisic2244>
- Mason, J. (2002). *Qualitative researching*. Sage Publications.
- Matei, S. A., & Hunter, L. (2021). Data storytelling is not storytelling with data: A framework for storytelling in science communication and data journalism. *The Information Society*, 37(5), 312-322.
- McKechnie, L., Julien, H., Pecoskie, J. L., & Dixon, C. M. (2006). The presentation of the information user in reports of information behaviour research. *Information Research*, 12(1) paper 258.
- McKenzie, P. J. (2001). *Negotiating authoritative knowledge: information practices across a life transition*. [Doctoral dissertation, University of Western Ontario].
- McKenzie, P.J. (2003). A model of information practices in accounts of everyday-life information seeking. *Journal of Documentation*, 59(1), 19-40. <https://doi.org/10.1108/00220410310457993>
- McKenzie, P. (2022). *Cosmic Zoom: An Approach to Studying Information Practices in Context* [Keynote]. Information Seeking in Context, Berlin, Germany, September 26-29, 2022.
- Mead, M. (1928). *Coming of age in Samoa: a psychological study of primitive youth for western civilisation*. William Morrow & Company.
- Nahl, D. (2007). The centrality of the affective in information behavior. In D. Nahl and D. Bilal (Eds.) *Information and emotion: The emergent affective paradigm in information behavior research and theory*, (3-37). Information Today.

- Nicolini, D. (2009). Zooming in and out: Studying practices by switching theoretical lenses and trailing connections. *Organization Studies*, 30(12), 1391-1418. <https://doi.org/10.1177/0170840609349875>
- Nirmala, M. J., & Divyananda, K. (2018). Information seeking behaviour among DRDO scientists in Defence Research Laboratories: a study. *Asian Journal of Information Science and Technology*, 8(1), 57-60.
- Niu, X., & Hemminger, B. M. (2012). A study of factors that affect the information-seeking behavior of academic scientists. *Journal of the American Society for Information Science and Technology*, 63(2), 336-353.
- Olsson, M. (2005). Making sense of sense-making: Information behavior researchers construct an 'author'. *Canadian Journal of Information & Library Science*, 29(3), 315-334.
- Olsson, M. (2007). Power/Knowledge: The discursive construction of an author. *The Library Quarterly*, 77(2), 219-240.
- Olsson, M. R. (2010). The play's the thing: Theater professionals make sense of Shakespeare. *Library & Information Science Research*, 32(4), 272-280. <https://doi.org/10.1016/j.lisr.2010.07.009>
- Olsson, M. (2016). Making sense of the past: The embodied information practices of field archaeologists. *Journal of Information Science*, 42(3), 410-419. <https://doi.org/10.1177/0165551510000000>
- Olsson, M. (2024). The data creation practices of archaeologists in the field. *Informaatitutkimus*, 43(3-4), 160-164.
- Olsson, M. (2025). Quantum leap: Practice architectures as a conceptual tool in information practices research. In *Proceedings of the Annual Conference of CAIS/Actes du congrès annuel de l'ACSI*. <https://doi.org/10.29173/cais2003>
- Olsson, M., & Lloyd, A. (2016). Being in place: Embodied information practices. *Information Research*, 22(1), CoLIS paper 1601.
- Osimani, B. (2014). Causing something to be one way rather than another: Genetic information, causal specificity and the relevance of linear order. *Kybernetes*, 43(6), 865-881.
- Palmer, J. (1991). Scientists and Information: II. Personal factors in information behaviour. *Journal of Documentation*, 47(3), 254-275.
- Palmer, C. L., & Cragin, M. H. (2008). Scholarship and disciplinary practices. *Annual Review of Information Science and Technology*, 42(1), 163-212.
- Palmer, C. L., Tefteau, L. C., & Pirmann, C. M. (2009). Scholarly information practices in the online environment. *Report commissioned by OCLC Research. Published online at: www.oclc.org/programs/publications/reports/2009-02.pdf*, 1, 2-1.
- Peerbaye, A., & Vinck, D. (2025). Laboratory Studies: Beyond a Founding Myth of STS. In S. Boudia, & A. Peerbaye, (Eds.) *Science and Technology in Society*, (pp. 29-52). Wiley.
- Pickering, A. (1984). *Constructing Quarks: A sociological history of particle physics*. University of Chicago Press.
- Pickering, A. (1995). *The mangle of practice: Time, agency, and science*. University of Chicago Press.

- Pickering, A. (2017). The ontological turn: Taking different worlds seriously. *Social Analysis*, 61(2), 134-150. <https://doi.org/10.2307/j.ctv1850gsb.12>
- Pilerot, O. (2012). LIS research on information sharing activities—people, places, or information. *Journal of Documentation*, 68(4), 559-581.
- Pilerot, O. (2014a). *Design researchers' information sharing: the enactment of a discipline*. [Doctoral dissertation, University of Borås].
- Pilerot, O. (2014b). Making design researchers' information sharing visible through material objects. *Journal of the Association for Information Science and Technology*, 65(10), 2006-2016. <https://doi.org/10.1002/asi.23108>
- Pilerot, O., & Ekström, B. (2025). Information practice and information behaviour: on the need for conceptual and theoretical clarity. *Information Research*, 30 (CoLIS), 461-473. <https://doi.org/10.47989/ir30CoLIS52270>
- Pilerot, O., Hammarfelt, B., & Moring, C. (2017). The many faces of practice theory in library and information studies. *Information Research*, 22(1), CoLIS paper 1602.
- Pollner, M., & Emerson, R. M. (2001). Ethnomethodology and ethnography. In P. Atkinson, A. Coffey, S. Delamont, J. Lofland, & L. Lofland, (Eds), (2001). *Handbook of ethnography*. (pp. 118-135). Sage Publications.
- Pratt, M. L. (1986). Fieldwork in common places. In J. Clifford, & G. Marcus (Eds.) *Writing culture: The poetics and politics of ethnography*. (pp. 27-50). University of California Press.
- Research Information Network. (2009). *Patterns of information use and exchange: case studies of researchers in the life sciences*. Research Information Network, British Library. http://www.rin.ac.uk/system/files/attachments/Patterns_information_use-REPORT_Nov09.pdf
- Richardson, L. (2003). Writing: A method of inquiry. In Y. Lincoln & N. Denzin (Eds.). *Turning points in qualitative research: Tying knots in a handkerchief*, (375-379). Altamira Press.
- Riles, A. (Ed.). (2006). *Documents: Artifacts of modern knowledge*. University of Michigan Press.
- Ritchie, J., & Lewis, J. (Eds.) (2003). *Qualitative research practice: A guide for social science students and researchers*. Sage Publications.
- Roh, F. (1925). Magical realism: Post-expressionism. In L.P. Zamora & W.B. Faris (Eds). *Magical Realism: Theory, History, Community* (1995, pp. 15-31). Duke University Press.
- Roos, A. (2015). Medical scientists' information practices in the research work context. *Health Information & Libraries Journal*, 32(1), 23-36.
- Rosaldo, R. (1986). From the door of his tent: The fieldworker and the inquisitor. In J. Clifford, & G. Marcus (Eds.) *Writing culture: The poetics and politics of ethnography*. (pp. 77-97). University of California Press.
- Ryan, G. S. (2017). An introduction to the origins, history and principles of ethnography. *Nurse Researcher*, 24(4), 15-21.
- Sahu, H. K., & Nath Singh, S. (2013). Information seeking behaviour of astronomy/astrophysics scientists. *Aslib Proceedings*, 65(2), 109-142.

- Savolainen, R. (1995). Everyday life information seeking: Approaching information seeking in the context of "Way of Life". *Library & Information Science Research*, 17(3), 259-294.
- Savolainen, R. (2007). Information behavior and information practice: Reviewing the "umbrella concepts" of information-seeking studies. *The Library Quarterly*, 77(2), 109-132.
- Savolainen, R. (2008). *Everyday Information Practices: A Social Phenomenological Perspective*. Scarecrow Press.
- Savolainen, R. (2012). Conceptualizing information need in context. *Information Research*, 17(4), paper 534.
- Savolainen, R. (2014). Emotions as motivators for information seeking: A Conceptual analysis. *Library & Information Science Research*, 36(1), 59-65. <http://dx.doi.org/10.1016/j.lisr.2013.10.004>
- Savolainen, R., & Thomson, L. (2022). Assessing the theoretical potential of an expanded model for everyday information practices. *Journal of the Association for Information Science and Technology*, 73(4), 511-527. <https://doi.org/10.1002/asi.24589>
- Savolainen, R. (2023). Everyday life as an evolving context of information behaviour. *Aslib Journal of Information Management*, 75(5), 940-960.
- Schatzki, T.R. (2002). *The site of the social: A philosophical account of the constitution of social life and change*. Penn State University Press.
- Schatzki, T. R. (2003). A new societist social ontology. *Philosophy of the Social Sciences*, 33(2), 174-202. <https://doi.org/10.1177/0048393103251680>
- Schatzki, T. R., Knorr-Cetina, K., & Von Savigny, E. (Eds). (2005). *The practice turn in contemporary theory* (5th ed.). Routledge.
- Schatzki, T. (2016). Practice theory as flat ontology. In G. Spaargaren, D. Weenink, & M. Lamers (Eds.), *Practice theory and research: Exploring the Dynamics of Social Life* (pp. 44-58). Routledge.
- Schindler, L., & Schäfer, H. (2021). Practices of writing in ethnographic work. *Journal of Contemporary Ethnography*, 50(1), 11-32.
- Searle, J. R. (1995). *The construction of social reality*. Simon and Schuster.
- Shapiro, J. A. (2007). Bacteria are small but not stupid: cognition, natural genetic engineering and socio-bacteriology. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences*, 38(4), 807-819.
- Shankar, K. (2004). Recordkeeping in the production of scientific knowledge: an ethnographic study. *Archival Science*, 4(3), 367-382.
- Shaw, R. R. (1948). Royal Society Scientific Information Conference. *Science*, 108(2798), 148-151. <https://doi.org/10.2307/2682685>
- Skinner, J. (Ed.) (2012). A four part introduction to the interview: Introducing the interview; Society, sociology and the interview; Anthropology and the interview; Anthropology and the interview – edited. In *The Interview: An Ethnographic Approach* (pp. 1-49). (Association of Social Anthropologists of the UK and Commonwealth - Monographs). Bloomsbury.
- Skinner, J. (Ed.) (2013). *The Interview: An Ethnographic Approach* (Vol. 49). Taylor & Francis Group.

- Slemon, S. (1995). Magic Realism as Postcolonial Discourse. In L.P. Zamora, & W.B. Faris, (Eds.) *Magical realism: Theory, history, community*, (407-426). Duke University Press.
- Smith, V. (2001). Ethnographies of work and the work of ethnographers. In P. Atkinson, A. Coffey, S. Delamont, J. Lofland, & L. Lofland, (Eds), (2001). *Handbook of ethnography*. (pp. 220-233). Sage Publications.
- Spaargaren, G., Lamers, M., & Weenink, D. (2016). Introduction: Using practice theory to research social Life. In G. Spaargaren, D. Weenink, & M. Lamers (Eds.) *Practice Theory and Research* (pp. 19-43). Routledge.
- Šustar, P. (2007). Crick's notion of genetic information and the 'central dogma' of molecular biology. *The British Journal for the Philosophy of Science*, 58(1), 13-24.
- Talja, S. (1997). Constituting "information" and "user" as research objects: A theory of knowledge formations as an alternative to the information man-theory. *ISIC '96: Proceedings of an international conference on Information seeking in context* (pp. 67-80). Taylor Graham Publishing.
- Talja, S. (2010). Jean Lave's Practice Theory. In G.J. Leckie, L.M. Given, & J.E. Buschman (Eds.). *Critical Theory for Library and Information Science: Exploring the Social from Across the Discipline* (pp. 205-220). Libraries Unlimited.
- Talja, S., Tuominen, K., & Savolainen, R. (2005). "Isms" in Information Science: Constructivism, collectivism and constructionism. *Journal of Documentation*, 61(1), 79-101.
<https://doi.org/10.1108/00220410510578023>
- Taussig, M. (1992). *The nervous system*. Routledge.
- Taussig, M. T. (2010). *The devil and commodity fetishism in South America*. University of North Carolina Press.
- Thakral, Y. (2021). Social (In)equities and ethical challenges: Role of information practices in antimicrobial resistance in India. *Health Technology Assessment in Action*, 5(4).
<https://doi.org/10.18502/htaa.v5i4.10167>
- Tourney, M. M. (2003). Caging virtual antelopes: Suzanne Briet's definition of documents in the context of the digital age. *Archival Science*, 3, 291-311.
<https://doi.org/10.1007/s10502-004-4038-2>
- Tuominen, K., & Savolainen, R. (1997). A social constructionist approach to the study of information use as discursive action. In P. Vakkari, R. Savolainen & B. Dervin (Eds.) *ISIC '96 Proceedings of an International Conference on Information Seeking in Context*, (81-96). Taylor Graham Publishing.
- Van House, N. A. (2004). Science and Technology Studies and Information Studies. *Annual Review of Information Science and Technology (ARIST)*, 38, 3-86.
- van Leeuwenhoek, A. (2017). *The Select Works of Anthony van Leeuwenhoek: Containing his Microscopical Discoveries in Many of the Works of Nature* (S. Hoole, Trans.). HardPress. (Original work published 1728).
- Van Maanen, J. (1995). Style as theory. *Organization Science*, 6(1), 133-143.
- Van Maanen, J. (2011). *Tales of the field: On writing ethnography* (2nd ed.). University of Chicago Press.

- Verrall, R. (Director) (1968). *Cosmic Zoom* [Animation], National Film Board of Canada.
- Weber, M., & Huisken, J. (2021). Multidisciplinarity is critical to unlock the full potential of modern light microscopy. *Frontiers in Cell and Developmental Biology*, 9, 739015.
- White, M. D., & Marsh, E. E. (2006). Content analysis: A flexible methodology. *Library Trends*, 55(1), 22-45.
- Whittle, A., & Spicer, A. (2008). Is actor network theory critique?. *Organization Studies*, 29(4), 611-629.
- Williams, L., Cox, A., & Jimenez, A. (2024). Creating, using, and sharing embodied information in the ultrarunning community on Instagram. *Information Research*, 29(2), 635-651.
- Wilson, T. D. (2000). Human information behavior. *Informing Science*, 3(2), 49-55.
- Yerbury, H., Perera, P., & Olsson, M. (2022). Conceptions of place in the information practices of the Mahamewnawa Asapuwa Temple community. *Information Research* 27 (Special Issue, isic2237). <https://doi.org/10.47989/irisc2237>
- Yerbury, H., & Henninger, M. (2025). Knowing and not knowing about algorithms. *Journal of Documentation*, 81(2), 301-312. <https://doi.org/10.1108/JD-04-2024-0076>.
- Zamora, L. P., & Faris, W. B. (Eds.) (1995). *Magical realism: Theory, history, community*. Duke University Press.
- Zhang, D., Pee, L. G., Pan, S. L., & Wang, J. (2024). Information practices in data analytics for supporting public health surveillance. *Journal of the Association for Information Science and Technology*, 75(1), 79-93. <https://doi.org/10.1002/asi.24841>
- Zhong, H., Han, Z., & Hansen, P. (2022). A systematic review of information practices research. *Journal of Documentation*, 79(1), 1-23. <https://doi.org/10.1108/JD-02-2022-0044>.

APPENDICES

Appendix 1 – Interview Protocol



Semi-structured Interview Questionnaire

RESEARCH DETAILS
Research Title: From Objects to Information: An Investigation in how Scientists learn and Construct Information from their Objects of Study – [HREC APPROVAL NUMBER]

Research student: Giovanni Forero: [] – Giovanni.E.Forero@student.uts.edu.au
Principal supervisor: []
Alternate Supervisor: []

METHODOLOGY
Semi-structured interviews in qualitative researches have the aim of exploring the point of view and personal impressions of interviewees, to understand the individual understandings about a particular situation or subject matter. There is a greater flexibility in the formulation of questions and they are used as a guide so interviewees are able to express their perspectives regarding the subject. Therefore, tangents and diversion from prepared questions is encouraged.

INTRODUCTION
To thank the participants for their time and to explain the semi-structure methodology.

INTERVIEW GUIDE
The following are the prepared questions that will serve as a guide for this interview:

1. May I have your name?
2. How long have you been participating on this research?
3. Which is your role on this investigation?
4. Could you describe your role within the laboratory?
5. Can you please describe which the functions of your role are?
 - a. **Probe:** Can you please expand on the use of technology¹ "X"?
 - b. Other probe questions could emerge at this point, depending on how the interviewee express his or her relation with the technology and its impact on how information is drawn from the bacteria.
 - c. **Probe:** Can you please expand on the procedure you just mentioned?
6. Can you please describe in your own words, which is the aim of this research?
7. What was your understanding (if any) of this bacteria² (To be replaced by the actual name) before your participation on this investigation?
 - a. Probe questions will most probably arise to clarify some of the qualifications used to refer to the bacteria²
8. Can you describe how your knowledge or understanding about this bacteria² has changed since your involvement on this research?
 - a. Probe questions will most certainly arise as a result on this explanation, in order to understand the personal impressions and subjective perspectives of the interviewee.
9. Can you please define what the meaning of "bacteria lifestyles" is?
 - a. Probe question could emerge from this point as well.
10. How do you think technologies like UTS Data Arena or DeltaVision OMX 3D-SIM, help you to learn from your object of study?
11. How do you think the general knowledge about this bacteria² could change due to this research?
12. Using your own words, could you please describe the process from observing the bacteria² for first time to the moment a scientific paper is ready to be released?
13. Based on the prior question, how do you think this information transcends from observation to a final knowledge?
14. Which is the impact of the Data Arena and analysing in the understanding of Bacteria behaviour?
 - a. **Probe:** Can you explain the process of converting observations, to numbers, to visual data?
 - b. **Probe:** How do you think your view of the bacteria changed after appreciating the visualisation in oppose that through the microscope?

Semi-structure Interview Questionnaire – version 1, 20/08/2017 Page 1 of 2

Appendix 2 – Consent for Recording the Session



CONSENT FORM

From Objects to Information: An Investigation in how Scientists learn and Construct Information from their Objects of Study – [UTS HREC REF NO. ETH17-1639]

I _____ [participant's name] agree to participate in the research project **From Objects to Information: An Investigation in how Scientists Learn and Construct Information from their Objects of Study – [UTS HREC REF NO. ETH17-1639]** being conducted by Giovanni Forero Master of Arts research Student [Giovanni.E.Forero@student.uts.edu.au], _____

I have read the Participant Information Sheet, or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions, and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to be:

☐ Included during the observation stage
☐ Included during the interview stage
☐ Audio recorded (only during the interviews)

I agree that the research data gathered from this project may be published in a form that:

☐ Identifies me
☐ Do not identifies me*

**Please note that even though every effort will be made to de-identify the participant if this option is selected, this is not always possible as some of the context could lead to your potential identification.*

I wish to review the sections that include my pseudonym:

☐ Yes
☐ No

I am aware that I can contact Giovanni Forero or the supervisors if I have any concerns about the research.

Name and Signature [participant]	Date
Name and Signature [researcher or delegate]	Date

Supervisors Details:
Principal supervisor: _____

Consent form – version 2, 19/08/2017Page 1 of 2

