FORMATIVE ACCOMPANYING RESEARCH

WITH

COLLABORATIVE INTERDISCIPLINARY TEAMS

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Thesis submitted by Rebecca Freeth

born 14 December 1972 in Yorkshire, England

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I have loved being surrounded by great natural beauty in this part of Germany. My wish for all women is that they could experience the safety I have felt while exploring this landscape on foot and bike.

And then to the friends and community back home, thank you for being so gracious about me disappearing again. The fact that these friendships have not only endured over my

absence, but in many cases have strengthened is a source of wonder to me. I have felt celebrated and cheered me on from afar. Dhammamegha, you're always with me. Mom, dad, Timo and Sarah, thank you for being my family. I feel profoundly seen and loved by each of you. Qiniso and Nqobile, I am most proud of you.

PROLOGUE

In the sustainability science context in which I find myself, it is not common to produce a doctoral thesis that includes material of a deeply personal nature alongside scientific work.

Part of my intention in my doctoral work has been to learn how to span multiple subject matters and present my ideas, arguments and findings in multiple registers, for multiple audiences. This is an interdisciplinary undertaking, inspired by working in an interdisciplinary team where I initially found myself disconcertingly incomprehensible to some of my colleagues. As they were to me. Mutual incomprehension does not bode well for the collaborative field of sustainability research. We had to learn how to make ourselves understandable.

In this thesis therefore, you will find an assortment of registers. I have not found it easy to switch between vernaculars, formats, writing styles or kinds of logic, without losing the ways in which I recognize myself. As a reader, you may not find it easy to traverse the resulting assemblage of vernaculars, formats, writing styles and logics.

To throw you in at the deep end, I start with a poem about how difficult it can be to collaborate across disciplines. May you swim.

This permeable membrane
masquerading as a wall between
me, my way, what I claim as mine
and
you, your way, what you claim as yours.

What will I do?
Throw a rope over and start to climb?
Knock politely? Shoes and smile gleaming
Tunnel secretly beneath?
Web my feet and dive into the membrane?
Or tiptoe silently away
back to the sweet smell of home.

“Science is rife with contradictory forces that tug on its practitioners”

Edward Hackett, 2005
Essential tensions: Identity, control, and risk in research

“The question of what constitutes a flourishing existence, and the place of knowledge-seeking in that form of life, how it contributes to or disrupts it, must be constantly posed and re-posed in such a form that its realization becomes more rather than less likely.”

Paul Rabinow, 2011
The accompaniment: Assembling the contemporary

ABSTRACT

The image of the solitary scientist is receding. Increasingly, researchers are expected to work in collaborative interdisciplinary teams to tackle more complex and interrelated problems. However, the prospect of collaborating with others, from different disciplines, exerts countervailing forces on researchers. There is the lure of transcending the limitations of one's own knowledge, methods and conventions, belonging to diverse intellectual communities and tackling, together, ambitious research topics. On the other hand, there is the risk that collaborating across disciplinary boundaries will be taxing, confounding at times, with no guarantee of success. In short, interdisciplinary collaboration is both a desirable and difficult way to conduct research.

This thesis is about collaborative interdisciplinary research from the perspective of a formative accompanying researcher. I accompanied an interdisciplinary research team in the field of sustainability over three years for the duration of a collaborative project. Formative accompanying research (FAR) is an approach to 'research into research' that learns about, with and for a collaborative interdisciplinary team.

I found – through immersion in the literature, my own daily experiences of collaborating, and my observations – that interdisciplinary collaboration is very difficult. It requires a basic understanding and appreciation of other disciplines and methods, as well as the skills to integrate research inquiries and findings across diverse epistemologies. It also requires awareness that collaborative interdisciplinary research is more than an intellectual task of knowledge creation. Other factors matter, such as interpersonal relationships, power differentials, different research tempos and a sense of belonging. And these factors have an impact on processes and outcomes of collaborative knowledge creation. Knowing this implies a willingness to keep learning and to tolerate discomfort so as to cultivate deeper levels of collaborative capacity. I discovered that in these deeper levels lie skills for staying with inevitable tensions, for talking and listening to generate new understanding together, and for applying a researcher's frank curiosity to oneself too.

A formative accompanying researcher, who is part of the team she is researching, has to navigate delicate terrain. In this thesis, I develop a FAR methodology that takes seriously the questions of positionality and relationality, and reflect on the experiences of putting these into practice. A FAR practice involves remaining in dynamic movement between observing and participating, between exercising curiosity and care, and between the researchers' own sense of impartiality and investment in relation to the issues at hand.

There is merit in furthering the methodology and practice of FAR on its own terms. This includes attending to the skills required by a formative accompanying researcher to remain oriented within the concentric circles of research, relationship and loyalty that make up a collaborative team. There is also the question of how FAR, and other forms of research into research, can help to advance collaborative interdisciplinary research. I argue for creating the conditions in research teams that would enable treating collaboration as a capacity to develop, and that would facilitate team members' receptivity to learning with FAR. Furthermore, I explore dilemmas of intervening as a formative accompanying researcher and of sustaining dynamic positionality over the long-term.

In the field of sustainability research, and in multiple other research fields, the future is a collaborative one. This thesis is concerned with how to collaborate so that the experience and the outcomes lend themselves to what Rabinow terms a "flourishing existence".

ZUSAMMENFASSUNG

Das Bild des solitär forschenden Wissenschaftlers nimmt an Bedeutung ab. Wissenschaftler arbeiten vermehrt in kollaborativen interdisziplinären Teams, um so komplexen und vernetzten Problemfeldern besser gerecht zu werden. Die enge Zusammenarbeit mit Wissenschaftlerinnen und Wissenschaftlern aus anderen Disziplinen übt entgegengesetzte Kräfte auf die Forschenden aus. Einerseits eröffnet die interdisziplinäre Zusammenarbeit Möglichkeiten, die Grenzen des eigenen Wissens, der vertrauten Methoden und Konventionen hinter sich zu lassen, zu unterschiedlichen intellektuellen Communities zu gehören und gemeinsam anspruchsvolle Forschungsthemen anzugehen. Andererseits kann die intensive Zusammenarbeit über Disziplingrenzen hinaus anstrengend und verwirrend sein, und sie bietet keine sicheren Erfolgsaussichten. Kurz, interdisziplinäre Zusammenarbeit ist sowohl ein wünschenswerter wie auch schwieriger Weg, Wissenschaft zu betreiben.

Diese Dissertation befasst sich mit kollaborativer interdisziplinärer Forschung aus Sicht einer Wissenschaftlerin, die mit *formative accompanying research* eine spezielle Form der wissenschaftlichen Begleitforschung betreibt. Ich habe ein interdisziplinäres Team von Wissenschaftlerinnen und Wissenschaftlern im Bereich der Nachhaltigkeitsforschung über einen Zeitraum von drei Jahren begleitet, was der gesamten Projektlaufzeit entspricht. *Formative accompanying research* (FAR) ist ein Ansatz des Forschens über das Forschen, welcher über, mit und für ein kollaboratives interdisziplinäres Team lernt.

Durch Eintauchen in die Literatur, meine täglichen Erfahrungen der Zusammenarbeit, und meine Beobachtungen habe ich herausgefunden, dass interdisziplinäre Zusammenarbeit sehr schwierig ist. Interdisziplinäre Zusammenarbeit benötigt ein Grundverständnis und eine Wertschätzung anderer Disziplinen und Methoden sowie die Fähigkeit, Fragestellungen, Ansätze und Ergebnisse über epistemologische Unterschiede hinweg zu integrieren. Sie benötigt auch ein Bewusstsein dafür, dass interdisziplinäres Forschen mehr ist als intellektuelle Wissensgenerierung. Viele andere Faktoren wie zwischenmenschliche Beziehungen, Machtverhältnisse, unterschiedliche Forschungsgeschwindigkeiten und ein Zugehörigkeitsgefühl sind ebenso relevant. All diese Faktoren haben Einfluss auf die Prozesse und Ergebnisse von kollaborativer Wissensgenerierung. Daraus folgt, dass die Bereitschaft weiterhin zu lernen genauso sowie die Bereitschaft Unbehagen zu tolerieren notwendig sind, um tiefere Ebenen der Zusammenarbeit zu erreichen. Ich habe herausgefunden, dass auf diesen tieferen Ebenen Fähigkeiten liegen, um mit den unausweichlichen Spannungen umzugehen, um

miteinander ins Gespräch zu kommen und im Gespräch zu bleiben und einander zuzuhören, um gemeinsam ein neues, tieferes Verständnis zu erreichen.

Eine Wissenschaftlerin, die *formative accompanying research* betreibt und Teil des Teams ist, das sie beforscht, bewegt sich auf heiklem Terrain. In dieser Dissertation entwickle ich eine FAR-Methodik, welche Fragen der Positionalität und Relationalität ernst nimmt und damit auch eine einfordert diese zu reflektieren und zu praktizieren. Eine FAR-Praxis beinhaltet eine dynamische Bewegung zwischen Beobachten und Teilhaben, zwischen Neugier und Fürsorge, und zwischen Unparteilichkeit und Sich-einbringen, je nach Situation.

Mit dieser Arbeit trage ich zu einer Weiterentwicklung der FAR-Methodik und -Praxis bei. Dabei gehe ich auch auf die Fähigkeiten ein, die eine FAR-Wissenschaftlerin oder ein FAR-Wissenschaftler braucht, um sich auf den konzentrischen Kreisen des Forschens und der Beziehungen und Loyalität, die ein kollaboratives Team ausmachen, zu bewegen. Doch wie können FAR und andere Formen des Forschens über das Forschen dazu beitragen, kollaborative interdisziplinäre Forschung weiterzubringen? Ich habe im Zuge meiner Forschung erkannt, dass es sehr relevant ist, wie die Bedingungen in Forschungsgruppen zu gestalten sind. Wenn die Bedingungen es ermöglichen und befördern, dass die Teammitglieder die kollaborative interdisziplinäre Zusammenarbeit als Entwicklungspotential wahrnehmen, beeinflusst das wiederum positiv, wie Teammitglieder mit FAR lernen wollen und können. Darüber hinaus sondiere ich jene Dilemmata, die entstehen, wenn FAR-Forschende Interventionen vornehmen, und reflektiere die Herausforderung, auch über längere Zeitspannen hinweg in einer dynamischen Positionalität zu bleiben.

In Zukunft wird im Bereich der Nachhaltigkeitsforschung und in vielen anderen Forschungsbereichen interdisziplinäres kollaboratives Arbeiten zunehmen. Diese Dissertation beschäftigt sich mit der Frage, wie diese Zusammenarbeit so gestaltet werden kann, dass die Erfahrungen und Resultate dem entsprechen, was Rabinow eine „flourishing existence“ nennt.

TABLE OF CONTENTS

TABLES

FIGURES

CHAPTER 1

ACCOMPANYING A COLLABORATIVE INTERDISCIPLINARY RESEARCH TEAM IN THE FIELD OF SUSTAINABILITY

1 Introduction

At its simplest, collaboration means working with others and is a hallmark of human endeavour. A key factor that affects experiences of collaborating is the extent of similarity or difference between collaborators (Kahane, 2017; Oshry, 1995). Contemporary forms of collaboration tend to favour working with others on the basis of perceived differences. In myriad manifestations of human endeavour, from policymaking to the arts, and from commercial enterprise to social activism, there are strong moves to collaborate across traditional boundaries and to break through conventional silos. This commitment to bringing different perspectives to bear on a shared matter of concern is evident in research too (Hirsch Hadorn et al., 2010).

In this thesis, I focus on collaborative interdisciplinary research practiced in an academic team, distinct from transdisciplinary collaboration, which I understand to extend to diverse holders of knowledge and interest beyond academia (Barry and Born, 2013). However, the language of inter*disciplinary* collaboration masks other forms of difference between collaborators that may exert considerable influence on experiences of collaborating (Boix Mansilla et al., 2016). One implication is that when identifying researchers to collaborate with on the basis of disciplinary differences, multiple other sources of difference may not be taken into account. This suggests that such collaborations may be under-prepared to manage multiple sources of difference, both in terms of taking creative advantage of potential complementarities, and addressing inevitable challenges of diverse ways of being, thinking and acting (Cheruvelil et al., 2014; Fitzgerald et al., 2012; Read et al., 2015; Rhoten et al., 2009).

The field of sustainability has embraced collaboration with particular enthusiasm. Indeed, collaboration has come to be treated as a defining characteristic of sustainability research (van Kerkhoff, 2014). Sustainability researchers may seek to work with a highly diverse set of collaborators for a combination of reasons, including a spirit of curiosity and adventure, prospects of more satisfactorily addressing complex social and social-ecological research questions, and responsiveness to policy and funding signals (Brown et

al., 2015; Irwin et al., 2018; Parker and Hackett, 2012). In the face of climate change, species extinctions and loss of biodiversity, interdisciplinarity may be considered the only morally justifiable way for researchers to proceed.

Collaborative interdisciplinary research is an interesting human endeavour to study for several reasons, including that it is extremely difficult to do well. It is characterised as "unabatedly demanding" (Defila and Di Giulio, 2018: 101) with "high potential for dysfunction" (Strober, 2011: 70) and an "elusive pursuit" in terms of living up to its scientific promise (Roy et al., 2013: 745). For the ambitious academic, it represents more of a gamble on which to stake a career than a disciplinary path (Brown et al., 2015; Leahey et al., 2017) and implies delayed gratification on metrics considered critical indicators of professional success, such as publishing records and promotion opportunities (Klein and Falk-Krzesinski, 2017).

What are researchers to make of these contradictions between imperatives, incentives and rewards of collaborating on the one hand, and the challenges, pitfalls, and barriers on the other? When collaborative interdisciplinary research is treated as a solution to one set of problems (such as a mismatch between complex research inquiries and conventional forms of knowledge production), there is a risk of overlooking the challenges created by collaboration. But neglecting such challenges can seriously compromise collaborative experiences and outcomes (Bozeman et al., 2016; Öberg, 2009). In this thesis, I pay particular attention to the challenges and difficulties of collaboration in the interests of advancing interdisciplinary collaboration, especially in the field of sustainability research.

My research is based on three years of working as a formative accompanying researcher with the project Leverage Points for Sustainability Transformation, a collaborative interdisciplinary research team in the field of sustainability. The purpose of locating a formative accompanying researcher in the team was to be able to track the fine-grained processes of collaborative knowledge production and to deepen the understanding of team members themselves about these processes, with the potential to strengthen them during the project (Lang et al., 2014). Thus we conceptualized formative accompanying research (FAR) as a methodology to learn *about*, *with* and *for* a research team. In practice, this implies that FAR is characterised by movement in relation to a research team, guided by these three learning orientations. As a result, we see FAR as suited to the task of "compiling narratives in order to understand how interdisciplinary work is actually done" (Klein, 1990: 195) given "the paucity of empirical studies of how interdisciplinarity unfolds in practice" (Barry and Born, 2013: 2). It is possible then that the kind of insights FAR is designed to generate can help to advance the practice of collaborative interdisciplinary research. However, there is also a risk of becoming disorientated when conducting FAR

within a busy and complex interdisciplinary project. This raises questions of how to navigate dynamic FAR positionality in relation to a research team.

Thus, my work focuses on two research practices that are not necessarily related, but which I treat as connected practices. One is the practice of interdisciplinary research, focusing on collaboration. The other is the practice of formative accompanying research (FAR) to learn about, with and for a collaborative research team. I conceptualize each research practice separately, on its own merits, describe the connections between them, and address prospects to deepen these connections.

To sum up, this thesis aims to make a contribution to advancing collaborative interdisciplinary research. Towards realizing this aim, I shine a light on challenges, discomforts and paradoxes that are common to collaborative interdisciplinary research but at risk of being neglected. By identifying such difficulties, it is intended that they can be more clearly anticipated and considered when designing and practicing collaborative interdisciplinary research in sustainability and other fields. Furthermore, I propose an approach to conducting FAR. A measure of doing so successfully is if this approach is conceptually and methodologically interesting on its own terms, and if its practice can help advance collaborative interdisciplinary research.

The remainder of this chapter, which frames the thesis as a whole, is structured as follows. I outline my research inquiry in section 2, followed by an overview of the papers included in this cumulative thesis, how they contribute to my research inquiry and how they relate to each other (section 3). Section 4 presents the research situation, in which I also introduce myself as the researcher. The conceptual overview (section 5) and methodological approach (section 6) continue to elaborate the research backdrop before presenting my main results in the form of a summary of each of the four core papers (section 7). Section 8 provides a synthesis and considers implications of my research, also drawing on the papers in the appendices. I indicate future research directions before drawing conclusions (section 9).

2 Research Inquiry

The overarching aim of my doctoral research is to learn from conducting formative accompanying research in a collaborative interdisciplinary research team to support the advancement of collaborative interdisciplinary research for sustainability.

Table 1 outlines three areas of interest within this aim. Each area of interest translates into a research objective. In relation to each research objective, I identify a specific

concern that emerged during my early stages of fieldwork. Taking these concerns into account shapes the way in which I have formulated each research question.

Area of interest	Research objective	Specific concern	Research question
Methodology and practice of formative accompanying research (FAR)	To develop and apply a FAR methodology for learning about, with and for a collaborative interdisciplinary research team	Risk of formative accompanying researcher becoming disorientated while learning about, with and for a team, as a member of the team	How can a formative accompanying researcher navigate positionality in relation to a collaborative interdisciplinary research team?
Concept of collaborative interdisciplinary research	To investigate a conceptual framework for studying experiences of collaborative interdisciplinary team research	The language of inter*disciplinary* research masks multiple other sources of difference in collaborative interdisciplinary research	How can the concept of epistemic living spaces be adopted and adapted to study experiences of collaborative interdisciplinary research?
Practice of collaborative interdisciplinary research	To study researchers collaborating in an interdisciplinary team in the field of sustainability, with an interest to advance collaborative interdisciplinary practices	Collaborative interdisciplinary research is strongly promoted But it is extremely difficult to realise its potential in practice	What are the collaborative interdisciplinary experiences of researchers in the Leverage Points team? What have we learned that could advance collaborative interdisciplinary practices?

Table 1: Research inquiry

matching areas of interest with research objectives and specific concerns to produce four research questions.

My first area of interest is about a FAR methodology and practice. The second relates to the concept of collaborative interdisciplinary research. Together, these set the basis for being able to make empirical inquiries into the third area of interest, the practice of

collaborative interdisciplinary research. The research objectives are responsive to making progress in each of these areas of interest. My concerns in relation to each of these were expressed in the introduction to this chapter.

These areas of interest, objectives and concerns produce the following four research questions at the heart of my inquiry:

1) How can a formative accompanying researcher navigate positionality in relation to a collaborative interdisciplinary research team?
2) How can the concept of epistemic living spaces be adopted and adapted to study experiences of collaborative interdisciplinary research?
3) What are the collaborative interdisciplinary experiences of researchers in the Leverage Points team?
4) What have we learned that could advance collaborative interdisciplinary practices?

3 Overview of articles

The cumulative design of my thesis comprises four core papers from my research (three articles and a book chapter) and two additional articles attached as appendices. Table 2 provides an outline of the four papers, how they contribute to research areas of interest described in Table 1 and their current publication status.

I selected these four core papers because they showcase the methodological development of FAR, the conceptualization of collaborative interdisciplinary research and my empirical research with a collaborative interdisciplinary research team, using FAR. These papers constitute Chapters 2 to 5 of this thesis, in the same order as shown in Table 2.

These core contributions are supplemented by two additional contributions that provide contextual breadth and depth to my study of a single collaborative interdisciplinary team in the field of sustainability (details in Table 3). They represent insights gained as a formative accompanying researcher into the more tacit, but highly influential aspects of researchers' beliefs and worldviews (included as Appendix 1) and the constraints created by dynamics of researcher privilege in the northern European context (included as Appendix 2).

Paper	Contribution to research inquiry
Paper 1: Researching collaborative interdisciplinary teams: Practices and principles for navigating researcher positionality Freeth, Vilsmaier	Focuses on methodology and practice of FAR with illustrative material from empirical FAR
Paper 2: Learning to collaborate while collaborating: Advancing collaborative interdisciplinary research Freeth, Caniglia	Conceptualizes collaborative interdisciplinary research with empirical FAR illustrations from experiences in Leverage Points
Paper 3: Engaging creatively with tension in collaborative research: Harnessing the "I" and "we" through dialogue Freeth, Clarke, Fam	Explores the practice of collaborative interdisciplinary research, with empirical FAR
Paper 4: Advancing collaborative interdisciplinary research: Learning about, with and for a research team Freeth	Revisits the methodology of FAR based on empirical research practice

Table 2: Core papers included in this thesis

Paper	Contribution to research inquiry
Paper 5: Inside-out sustainability: The neglect of inner worlds for sustainability Ives, Freeth, Fischer	Locates my inquiry in the wider context of neglect of deeper drivers of change, including among researchers research in the field of sustainability
Paper 6: Burning to be understood Freeth	Locates my inquiry in the deeper context of injustice and privilege, including among researchers in the field of sustainability

Table 3: Supplementary papers included as appendices to this thesis

The relationship between these papers and how, as a body of work, this contributes to my research inquiry is best conceptualized graphically. Figure 1 represents the four core papers and how they are arranged in relation to one another. This figure also illustrates

their contributions in relation to the topic of collaborative interdisciplinary research and the field of sustainability.

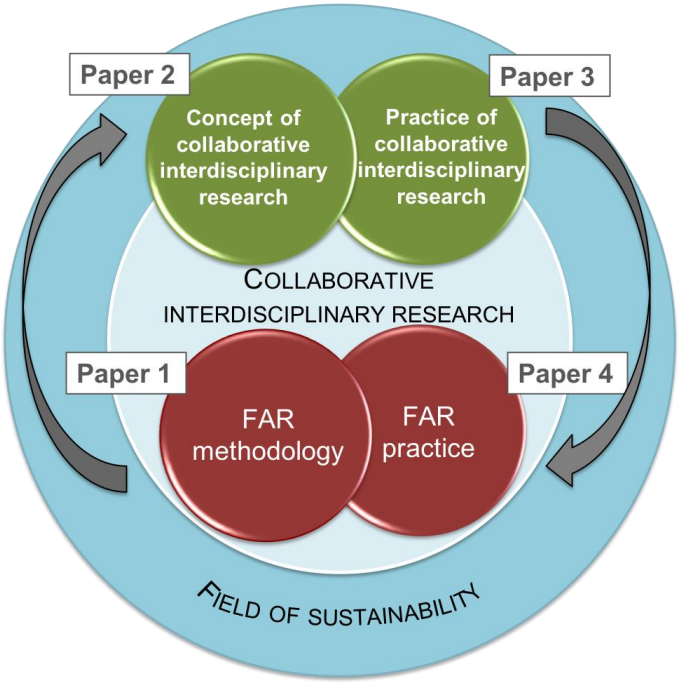

Figure 1: The four core papers included in this thesis

However, Figure 1 gives the impression of pursuing my research inquiry at a surface level, whereas I was also interested in the deeper conditions that produced what was visible on the surface. Therefore, Figure 2 represents a three-dimensional version of the perspective I adopted in my research. This figure highlights that the deeper conditions, while generally invisible, represent a deep source of leverage (Meadows, 2008) for changing how collaborative interdisciplinary research is conducted, in the field of sustainability.

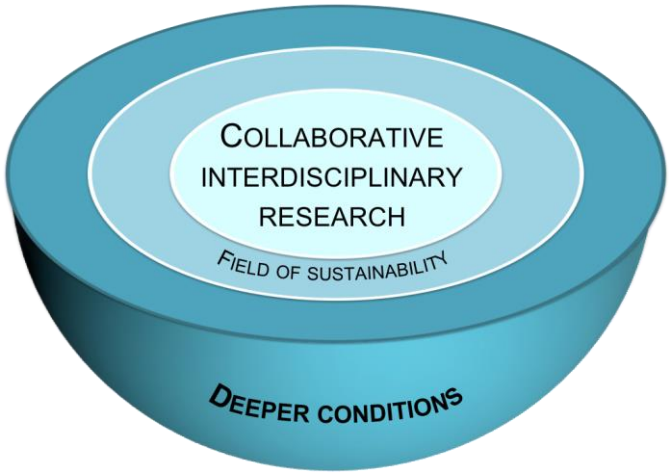

Figure 2: The three-dimensional perspective I adopted in my research

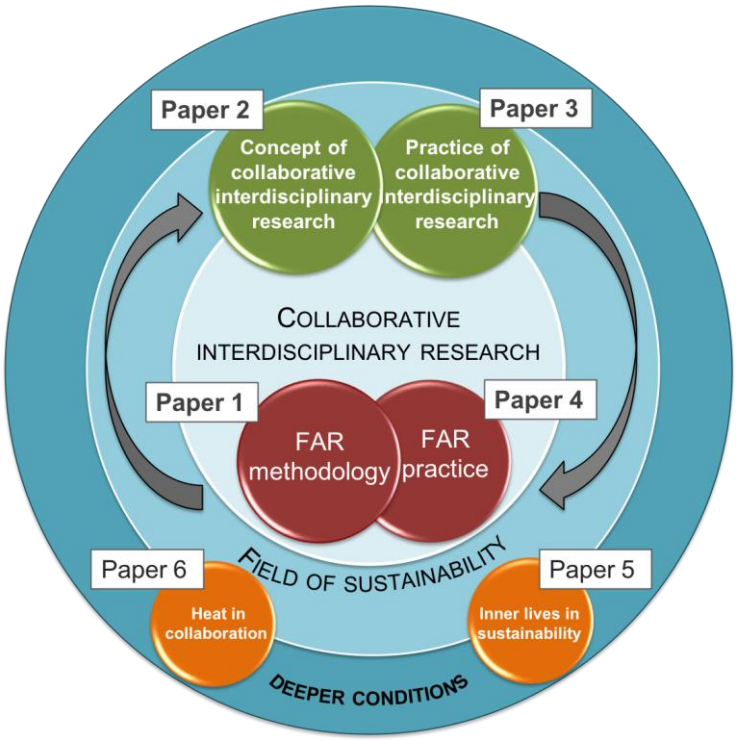

Figure 3: The four core papers and the two supplementary papers included in this thesis *relating to the deeper conditions in which collaborative interdisciplinary research and the field of sustainability are embedded.*

Therefore Figure 3 shows the inclusion of the two supplementary papers that pertain to the deeper conditions for collaborative interdisciplinary research. This work does not belong in the core part of the thesis because it is not directly related to my research

inquiry. However, it provides a larger perspective on my research and makes visible fundamental conditions that can either undermine or advance collaborative interdisciplinary research.

4 Research situation: University, project and researcher

4.1 Leuphana University

Leuphana University, in Lüneburg Germany, is cited as an example of the 'new' university, restructured to deliver an interdisciplinary education (Weingart and Padberg, 2014). It represents an institutional ethos that supports collaborative research projects, both interdisciplinary and transdisciplinary. Leuphana's sustainability faculty, established in 2010, was the first in Europe (https://www.leuphana.de/sustainability.html).

4.2 Leverage Points project

A small group of professors in the sustainability faculty of Leuphana initiated the Leverage Points project. These professors, who had known each other for several years, had been looking for a way to combine their respective research interests in a collaborative project. This core group responded to a research call issued by the federal state of Lower Saxony and the Volkswagen Foundation by inviting other colleagues in the faculty with whom they wanted to work, creating a working group of eight people who collectively developed the proposal.

Inspired by the work of Donella Meadows, this working group entitled the project 'Leverage Points for Sustainability Transformation: Institutions, People, Knowledge'. The project was designed to investigate the potential of deep, but under-researched, leverage points to foster sustainability (https://leveragepoints.org). Deep leverage points are sources of change in which a relatively small change can generate a large effect (Meadows, 2008). Using inter- and transdisciplinary research, the project specifically focused on three realms of leverage, rethinking knowledge for sustainability, reconnecting people and nature, and restructuring institutional arrangements (Abson et al., 2016). When the Leverage Points proposal won a research grant, the original team of eight principal investigators recruited twelve post-doctoral and doctoral researchers from seven countries, spanning multiple disciplinary fields. All members of the team were co-located at Leuphana University for between three and four years. Recognizing the opportunity to learn, *in situ* about the rewards and rigors of large interdisciplinary collaborations, especially in the field of sustainability research, the project proposal

included a PhD position for a formative accompanying researcher in the new team. This was a newly coined research role and one that has since been included in several other collaborative research projects in Leuphana University's sustainability faculty. The formative accompanying researcher's task was to "critically reflect on the processes of knowledge production [and] provide ongoing and iterative guidance for 'effective' knowledge production within the project itself, as well as generate a more general understanding of knowledge production processes within … sustainability science…" (Lang et al., 2014: 18–19).

4.3 Formative accompanying researcher

It is in keeping with the principles of FAR positionality (Paper 1) to make myself visible as a researcher. Moreover, Montuori (2008: xxvii) advocates "…making transparent the knower's assumptions …" especially in situations that transcend disciplinary boundaries. For Meadows (2008: 162), the "big unstated assumptions" are the deepest leverage points, *if* they are known and, perhaps, even relinquished. Following this logic, I introduce myself here on the basis of some of my assumptions.

In late 2015, I came from South Africa to take up the role of formative accompanying researcher. As a mid-career practitioner, I had not planned to undertake a PhD. However, when I heard about the Leverage Points project, I found it irresistible for several reasons. First, I had completed an MPhil in sustainable development, planning and management. In my dissertation, I had argued for ways to engage with social, and especially racial, injustice as a basis for a more sustainable South Africa. Second, I had spent many years facilitating multi stakeholder collaborations and therefore came to the Leverage Points project with a firm belief in collaboration as a necessary approach to addressing intractable social and social-ecological problems. Third, as part of that work, I had visited Germany once before, as a facilitator of a project working on transmission of intergenerational memory. This experience had awakened an appreciation of unconscious legacies inherited through organizations and families. I therefore arrived with assumptions about a grant being administered by the Volkswagen Foundation, originally set up with proceeds arising from confiscated assets of the Volkswagen company established as one of Adolf Hitler's "pet projects" (History.com editors, 2009). Fourth, I had helped to develop and teach a course entitled 'systems thinking for social change', which used Meadows' work on leverage points as a core text. While the leverage points concept held significant appeal to me, my application of this concept remained limited. I expected that by joining the project, I would be able to engage much more profoundly with the concept of leverage points and contribute to taking Meadows' work to a next level.

While it is an illusion that any researcher comes to their research empty of preconceptions (Roth and Breuer, 2003), I arrived relatively full of assumptions, experiences and expectations. These necessarily influenced what I saw as a researcher, and were also challenged in the course of my research. For example, focusing my research on difficulties of collaboration was an outcome of experiences in the Leverage Points project, but framed through my own expectations of it. Similarly, the approach to FAR positionality is shaped in part by my own life and work experience (Paper 1). I discuss methodological implications of bringing previous life experience to current research inquiries in section 6 of this framing paper. Following Haraway (1996: 441), I am interested in what it requires of a researcher to "bring the technical and the political back into realignment so that questions about possible liveable worlds lie visibly at the heart of our best science – and science studies."

5 Conceptual overview

Just before his death and in the same year as the Rio Earth Summit of 1992, Félix Guattari issued an uncharacteristically trenchant clarion call to rethink the practice of research. His article, originally entitled "Ethical and political foundations of interdisciplinarity" (the 2015 translation of which was, confusingly, renamed "Transdisciplinarity must become transversality") argued that interdisciplinary research was failing to live up to its promise. He wrote,

"Everyone is aware that the complexity of the objects of research in the domain of the human and environmental sciences demands an interdisciplinary approach. But the encounter between disciplines does not permit a decompartmentalization of the problematics and modes of expression brought together. Signs are made from one domain to another in the absence of any in-depth communication. How is a bridge to be established between living ecosystems?" (Guattari, 2015: 131)

He continued,

"International scientific life is often tangled up in formal rituals, in a sham interdisciplinarity. Its deepening implies a permanent 'research into research', an experimentation with new paths for the constitution of collective assemblages of enunciation." (Guattari, 2015: 135)

The reason for quoting Guattari at length is that he brings into a single frame three concepts on which this thesis is premised: interdisciplinary research, research into interdisciplinary research and more sustainable futures. And he does so with a similar spirit of aspiration to the one that imbues my research. In the remainder of this section, I

clarify my conceptual understanding of (collaborative) interdisciplinary research, formative accompanying research and sustainability.

5.1 Collaborative interdisciplinary research

The National Academy of Sciences (NAS) in North America defines interdisciplinary research as "... a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice." (NAS, 2005: 26).

Following this definition, interdisciplinary research can either be conducted as a solo pursuit or collaboratively. This basis for differentiating practices of interdisciplinarity has been productively explored (e.g., McCarty, 2016) but is surprisingly often unheeded (Klein, 2010). In this thesis, I use the term collaborative interdisciplinary research to make clear that I am referring to a teamwork approach, which is a significantly different kind of endeavour than conducting interdisciplinary research alone.

The NAS definition is clear, widely accepted and cited. Despite this, debates about what is included or excluded in the practice of interdisciplinary research persist. This hampers the study of interdisciplinary research for two main reasons. First, the relationship of interdisciplinary research to other forms of research that are not mono-disciplinary remains strongly contested. In his introduction to the 2nd edition of The Oxford Handbook of Interdisciplinarity, Frodeman (2017: 3) notes "… the fraught nature of conversations surrounding the term [and] the varied and even contradictory meanings assigned to it …". In some settings, interdisciplinarity includes research conducted in collaboration with people outside academia, whereas in other contexts this is a distinctly different research practice conceptualized as transdisciplinarity (Jasanoff, 2013). Multiple attempts have been made to develop taxonomies and typologies that clarify distinguishing features of multi-disciplinary, cross-disciplinary, interdisciplinary and transdisciplinary research (e.g., Huutoniemi et al., 2010; Klein, 2010, 2017). The unresolved status of these debates creates distraction away from the empirical study of research defined by its own practitioners as interdisciplinary. For example, Rylance (2015: 314) argues that research intended to guide future funding of interdisciplinary collaboration is hampered by "hair-splitting" taxonomies and "arcane debates" about what interdisciplinary is and is not. Second, the predominantly exclusive focus on its epistemic character, as in the case of the NAS definition, excludes other sources of similarity or difference that researchers contribute to collaborative interdisciplinary research and which have an impact on

collaboration. To be able to investigate experiences of collaborative interdisciplinary research without being hampered by these factors, I have adopted the concept of epistemic living spaces.

5.2 Epistemic living spaces

Felt conceptualized epistemic living spaces to "capture researchers' individual or collectively shared imaginaries and experiences of the institutional, social, epistemic, symbolic and policy structures they live in." (Felt et al., 2010: 7). Felt (pers. comm. 2016) considers the constitutive dimensions of an epistemic living space highly adaptable to the research question at hand and at various times has enlisted several other dimensions to fit her own research needs, including temporal and spatial dimensions. The epistemic living spaces concept explicitly recognises "tensions between heterogeneities in contemporary research cultures" (Felt et al., 2010: 8) and what this suggests for "feeling intellectually and socially 'at home'" (Felt, 2009: 19) in research and for experiencing "safe ground from which unknown territories may be explored and claims made." (Ibid.). Felt and colleagues employ this concept to acknowledge some of the difficulties facing researchers: "Talking about epistemic living spaces tries to point at the messiness, embattledness and practical significance of what seems to delimit researchers' capacity to act …." (Ibid.).

In adopting this concept for my empirical work, I settled on the five most frequently used dimensions of an epistemic living space in Felt's body of work - namely, epistemic, social, symbolic, spatial and temporal (Paper 2). I adapted the existing definitions of each of these dimensions to increase their relevance to experiences of collaborating in the field of sustainability research (Box 1). I emphasised experiences that I observed or that were recounted to me by researchers over their imaginaries.

Although Felt and her colleagues refer to both the individual and collective scale of experiences in research, they have paid less attention to the collective scale of interdisciplinary research in their own research. I adapted the concept for the purposes of studying the Leverage Points team as a unit, which I called 'collaborative epistemic living spaces'. This informed my empirical approach, through formative accompanying research, which emphasized an appreciation of the collaboration as a complex system, focusing not only on the individual researchers, but also on the connections between them, what is distributed through those connections and what patterns emerge (Cilliers, 2001; Meadows, 2008). Such an approach is rooted in an understanding of teams espoused by sociologist Elias Norbert, that "people's actions and experiences intermesh in a dynamic patterning process in which the individual and the social arise together … the social being

the plural and the person being the singular of the same process of relating." (Shaw, 2002: 73).

The *epistemic* dimension focuses on different assumptions about which research questions are central, how knowledge should be produced and which properties and procedures constitute good knowledge (Felt and Fochler, 2012). In the field of sustainability research, interdisciplinary teams are tasked with creating knowledge that is salient, credible and legitimate (Cash et al., 2003), while accepting that uncertainty and lack of consensus will always be a feature of their work (Miller, 2013);

The *social* dimension highlights the range of ways of being together in research and relations with both peers and competitors in collaborative knowledge production (Felt et al., 2012). Included in the social dimension are the emotional dynamics of interdisciplinary collaboration (Boix Mansilla et al., 2016; Griffin et al., 2013), which encompass interpersonal experiences of psychological safety and trust (Edmondson, 1999; Parker and Hackett, 2012) . Given the focus of sustainability research on future wellbeing, teams of sustainability researchers may be particularly emotionally invested in their work (Hoggett and Randall, 2016);

The *symbolic* dimension pays attention to competing values and top-down modes of ordering in governing and organizing research, and the resulting expectations that trickle down to researchers, such as contemporary expectations of research excellence or accountability (Felt et al., 2012). In sustainability research, power differentials are of particular relevance (Vilsmaier et al., 2017; Wals and Corcoran, 2012). There is also growing acknowledgement that sustainability researchers, perhaps more so than in most fields, tend to hold strong, and sometimes conflicting, assumptions about what constitutes a sustainable future (Schmieg et al., 2017);

The *spatial* dimension encompasses literal ways in which different spaces enable or constrain collective research work, as well as a metaphorical sense of belonging within different research communities (Felt and Fochler, 2012; Gieryn, 2000; Star and Griesemer, 1989). While much sustainability research is local and place-based, research teams themselves are often international, representing a diversity of experiences shaped by nationality, ethnicity and global geo-politics (Balvanera et al., 2015); and

The *temporal* dimension deals with different tempos, time regimes and forms of time in interdisciplinary research, particularly when different times frames – of projects, contracts and careers – are involved (Felt et al., 2012). Different disciplines conduct research at different paces (Felt, 2009). In sustainability research, there is the added pressure of a sense of urgency in relation to the wellbeing of social-ecological systems (van der Leeuw et al., 2012).

Box 1: Composite definitions of five core dimensions of a collaborative epistemic living space with characteristics of sustainability research added (Paper 2).

5.3 Formative accompanying research

Despite concerns about collaborative interdisciplinary research failing to meet aspirations for it, "[T]here has been strikingly little attention to what large-scale and complex interdisciplinary projects actually look like in the making." (Callard et al., 2015: 4). Due to the location of a formative accompanying researcher within a collaborative team, FAR is well placed to contribute to addressing this gap.

As a form of research into research, FAR is related to a series of methodologies and disciplinary fields that turn attention to the study of science. Half a century ago, Thomas Kuhn pointed to the fruitfulness of a "close observation of scientific life" (1996: 173) which has since been taken in multiple directions by science studies (e.g., Latour, 1999), observations of laboratory life (e.g., Knorr Cetina, 1999), science and technology studies (STS) (Jasanoff, 2013) and the science of team science (e.g., Bozeman et al., 2016). These different ways of researching the researchers have implications for positionality.

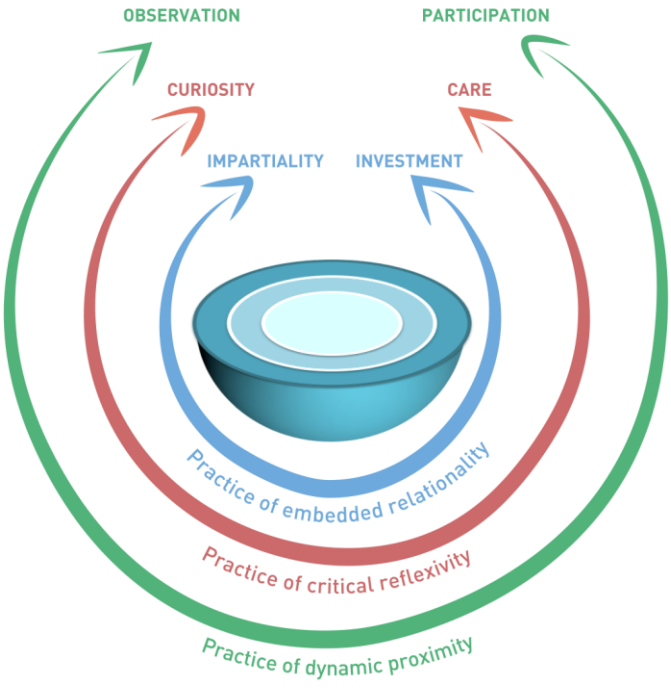

Figure 4: Navigating FAR positionality

FAR is best defined by its positionality in relation to a collaborative interdisciplinary team. A formative accompanying researcher is able to move nearer and further away from the team in order to learn about, with and for the team. We (Freeth & Vilsmaier) have thus

conceptualised FAR to be constituted in movement (Paper 1). Learning *about* has the epistemic goal to create transferable results, pursued in the role of scientific researcher. Only learning *about* is inadequate to researching a collaborative interdisciplinary team in ways that can also strengthen collaboration. We therefore included learning *with*, which has the goal to learn alongside a team in the role of a team member, and learning *for*, which has the goal of supporting the team to advance its research outcomes, in the role of an intervener. This creates the potential to share with a team initial FAR findings from learning *about*, in order to further explore, expand and make sense of these findings together (learning *with*), which could lead to identifying an intervention, to be performed by the formative accompanying researcher, to address jointly recognized challenges (learning *for*).

During the early stages of the research, we developed a FAR approach to navigating positionality (Figure 4). This approach includes three principles to balance methodological tensions between observation and participation, curiosity and care and impartiality and investment, as well as three principles (Paper 1). I had the opportunity to apply this in practice in the Leverage Points team in the field of sustainability research (Paper 4), although it is not exclusively applicable to this field. Relatively little research into research has been conducted in the field of sustainability to date, or even in interdisciplinary encounters between natural or social scientists. Thus experiences in the Leverage Points project represent opportunities to explore particular collaborative dynamics that arise in this context.

5.4 Sustainability

Throughout this thesis, I refer to 'sustainability research', which encompasses research conducted in the traditions of sustainability science (Kates et al., 2001) and sustainable development (Gallopin, 2003). According to Folke et al. (2002: 438) "…the transition to sustainability derives from a fundamental change in the way people think about the complex systems upon which they depend. Thus a fundamental challenge is to change perceptions and mind-sets, among actors and across all sectors of society … from the view of humanity as independent of nature to one of humanity and nature as co-evolving in a dynamic fashion within the biosphere." By sustainability research, I refer to knowledge production that ultimately supports the kinds of changes that Folke et al. outline. Herein lies the appeal of learning more about deep leverage points (Abson et al., 2016). The Leverage Points project was designed with the assumption that collaborative inter- and transdisciplinary research lends itself to producing such knowledge. This is captured in the project description which states that the project would draw on multiple research methods, tools, concepts and approaches to "generate a thorough

understanding of the importance, potentials and limitations of deep leverage points as means of fostering sustainability." (Lang et al., 2014: 5)

6 Methodological approach

The methodological dimensions of my research appear in several places in this thesis. Paper 1 outlines the methodological approach to FAR and Paper 4 explores the practice of FAR. However, my methodological work extended beyond experimenting with the nascent FAR methodology. Therefore, I use this methodology section of the framing paper to consider more broadly the philosophical assumptions underlying my methodological approach, the research process I followed and research strategies at each step of this process. To reiterate, the questions driving my research are:

1) How can a FAR researcher navigate positionality in relation to a collaborative interdisciplinary research team?
2) How can the concept of epistemic living spaces be adopted and adapted to study experiences of collaborative interdisciplinary research?
3) What are the collaborative interdisciplinary experiences of researchers in the Leverage Points team?
4) What have we learned that could advance collaborative interdisciplinary practices?

To respond to these questions, I crafted a qualitative mixed-methods research strategy that aligned my philosophical assumptions with methodological choices. Using an abductive research process, I moved through the phases of data collection, data sorting and analysis to interpretation and writing. I drew on a diverse range of data, methods and theories, faithful to the principle of triangulation. The remainder of this section provides more detail, with examples to illustrate my research practice.

6.1 Philosophical assumptions

The assumptions I carried into my work in the Leverage Points project (section 4 of this chapter) also translate into a series of methodological assumptions, expressed as preferences for particular ways of conducting research. In particular, combining my work experience as a dialogue facilitator, my philosophical interest in complexity theory (Cilliers, 2006) and my political interest in intergenerational memory makes me sympathetic to a "messy methods" framing (Law, 2004). To deal with inevitable uncertainty in research, "We need to find ways of elaborating quiet methods, slow

methods, or modest methods. In particular, we need to discover ways of making methods without accompanying imperialisms." (Law, 2004: 15).

The overarching interpretive framework for my research combines a social constructivist epistemology with a pragmatist sensibility (Creswell, 2013). This means I assume that both the researcher and the researched are constantly constructing their realities, that multiple versions of reality can co-exist, and that the versions of reality I choose to emphasize in my research should be useful. In the case of my doctoral research, I seek to contribute to advancing the practice of collaborative interdisciplinary research.

6.2 Abductive research process: Theory driven and data driven

A pragmatist sensibility lends itself to combining inductive and deductive research approaches (Creswell, 2013). Over the course of my study, I moved from more inductive to more deductive research approaches. A researcher who "starts with experience, considers all possible explanations to make theoretical conjectures about that experience, and then checks those conjectures through further experience" can be described as following an abductive logic (Stuart, 2018: 221). At spontaneous intervals, the inquiry process opened up for further iteration as new matters of interest, concern or care arise and appear to be worth paying attention to. Thus the research assumed a strongly iterative character. In this section I give an account of the abductive research process I followed.

The initial, inductive phase, which I have described as 'tracking' scents and leads (like a dog) gradually narrowed by filtering early interview and observational data through a set of sensitizing concepts identified in consultation with the research team. Grounded theory researcher Adele Clarke (1997:65) describes sensitizing concepts as "suggestive ideas about what might be potentially fruitful to examine and consider, an emergent meaningful vocabulary that alerts the researcher to promising avenues of investigation."

The experiences of interdisciplinary collaboration that I was observing and experiencing myself soon began to reveal a pattern that I found troubling and that corresponded with a theme of lively concern in the literature. This pattern related to the extent and depth of challenges faced in the process of collaborative interdisciplinary research. I therefore identified the gap between the promise and the pitfalls of collaborative interdisciplinary research as the third and final 'specific concern' driving my research questions (see Table 1 in section 2 of this chapter). As my research inquiry honed in on the challenges of collaboration, it was no longer appropriate to use a grounded theory approach. Even the reflexive approach to grounded theory (Breuer and Roth, 2003), which acknowledges

prior assumptions, did not accommodate the degree to which I was saturated with assumptions and theories about collaborative challenges, by virtue of my previous work as a practitioner.

Therefore, to consider a much wider set of interpretations and explanations about emerging challenges than the ones I had arrived with, I engaged with members of the team in one-to-one and collective settings. For example, a corridor conversation about the degree of diversity in the team led to 'diversity' rising to the top of my list of sensitizing concepts in the ensuing weeks. Experiences of diversity became a topic of walking conversations with several primary investigators in the project; I sought out literature on diversity in research teams, and focused my next FAR presentation to the team on this theme. I presented theory, finding and some tentative interpretations about this team's experiences of diversity as a basis for further discussion and shared meaning making. In that presentation, my colleagues challenged some of my interpretations, requiring me to continue investigating the data in relation to existing theory, explanations circulating in the team, and my pursuit of a pragmatic approach to working with diversity in collaborations. Over the three years, I presented my FAR research to the rest of the team six times. Their responses informed and enriched the ongoing abductive practice of refining my research approach, processes of data collection, analysis and interpretation. These are explained in more detail next.

6.3 Research strategies: From collecting data to writing up the research

My research strategy combined elements of grounded theory, ethnography, narrative research and action research. My philosophical assumptions prompted each move to a different method. For example, a narrative research method was influential in my approach to interviewing members of the team. I was interested in the stories they could tell about their collaborative research experiences to date (Czarniawska, 1997; Seideman, 2006). However, when analysing the data, I eschewed narrative methods (e.g., Riessman, 2008) because I found that this approach created units of analysis that were too fragmented for my purposes. I returned to a narrative approach when presenting my research results, in person and in writing because it provided sequential context of the team's collective experiences in a compelling format. Moreover, I found that narrative conveys provisional meaning, which can be deepened or revised through interaction with audiences (Elliott, 2005). In my experience, research audiences can, in turn, recognise aspects of the narrative that have relevance for their own situations and thus gain new insights for themselves. Like Riessman (2008), I have come to use 'story' and 'narrative' interchangeably.

Research phase	Philosophical assumptions	Research activity	Methodological theory
Data collection	All is data (Grounded theory) Scientific knowledge evolves in a social context and research methods are "messy" (Law, 2004: 12)	Participant observation of formal project gatherings (e.g. meetings, workshops, retreats, colloquiums and collaborative fieldwork)	Grounded theory: sensitizing concepts (Clarke, 1997) and theoretical sampling (Gentles et al., 2014); Ethnography (Jerolmack and Khan, 2018); Organisational ethnography (Eberle and Maeder, 2011)
		Participant observation of informal gatherings (e.g. lunch and tea breaks, kitchen and corridor chats)	
		Conducted semi-structured interviews	
		Maintained research journal	
		Conducted informal coding of observation field notes (multiple readings, highlighting, noting themes)	
Data sorting and analysis	Emergent process of pattern finding "…I let the categories build up all the time as I put things together that go together." (Marshall, 1981: 396)	Conducted informal coding of research journal (multiple readings, highlighting, keyword searches, noting themes)	Abductive logic, combining data-driven and theory-driven approaches (Stuart, 2018); Ethnographic STS (Balmer et al., 2016; Callard et al., 2015) ; Action Research (Reason and Bradbury, 2006)
		Conducted MAXQDA coding of interview material	
		Used key concepts, stabilised through my theoretical work, to investigate sorted data E.g. Five dimensions of a collective epistemic living space: what do they indicate about this team's experience? E.g. Learning about, for and with the team: what does this indicate about my FAR positionality?	
		Drew on reflections in research journal	
Interpretation	Making meaning is an intersubjective process (Wadsworth, 2006)	Made FAR presentations to the team and inviting discussion about the implications	Narrative approaches (Czarniawska-Joerges, 1995; Felt, 2017; Riessman, 2008); Action research (Reason and Bradbury, 2006)
		Took 'epistemic walks' with colleagues to reflect together on experiences in the team	
		Conducted further interviews to ask about the meaning colleagues ascribed to experiences in the team	
		Discussed draft findings with colleagues and inviting feedback on draft articles	
		Used narrative logic to create a coherent and sequential storyline that conveys team experiences	
		Presentations with colleagues and at symposia and conferences, testing ways of communicating a clear, coherent narrative	

Writing	"Narrative is both a mode of reasoning and a mode of representation" (Richardson, 1990: 21)	Producing a range of texts for different kinds of publications and different audiences	Narrative writing methods (Richardson, 1990)

Table 4: Triangulation of philosophical assumptions, methods and theories
organized according to research phases

In my sense-making work throughout the research process, I was inspired by Judi Marshall's approach to combining sharp and diffuse attention, which allows for insights to arrive once they have had time to percolate: "[L]ots of things come into my consciousness which perhaps I hadn't been aware of for years, and my mind is able to make connections at all sorts of levels. (1981:397). I found, for example, that bouts of very focused coding would be followed by unbidden but highly productive periods in which particular themes or narrative strands would occur to me while awaking from sleep, walking in nature, or doing a domestic task. Over subsequent hours and days, the notes these ideas produced would become multi-layered as they developed into nodes of thought, attracting further connections, questions and nuance.

Table 4 describes my approach to triangulation, defined by Repko (2012: 216) as the way in which "varieties of data, theories and methods" are combined. This table makes explicit the philosophical assumptions guiding my choice of empirical research activities in each phase of the research. These philosophical assumptions have ontological, epistemological, axiological and methodological dimensions (Creswell, 2013: 21). The research activities in the third column were supported by the methodological theories listed in the fourth column.

Table 5 expands on the first row of Table 4 above, providing specific detail about the data I collected.

6.4 Ethics

We (Freeth & Vilsmaier, in review) conceptualized the FAR practices and principles with the imperative of an ethical approach to FAR strongly in mind (Paper 1). I used these practices and principles as the foundation of my research ethics protocol. All members of the Leverage Points team received a detailed information sheet about my research and signed a consent form.

Research methods	Parameters	Total number
Participant observation of formal project gatherings	Participation observation sites – Meetings – Team workshops – Team retreats – Colloquiums – Collaborative fieldwork	Ongoing over three years – Approximately 40 – 5 – 7 – Approximately 40 – I accompanied 4 site fieldtrips (3 in Germany, 1 in Romania)
Participant observation of informal gatherings	E.g., lunch and tea breaks, kitchen and corridor chats	Ongoing over three years
Conducted semi-structured interviews	Baseline interview with all team members plus one additional interview with most team members	38 interviews
Maintained research journal	Recorded my activities, experiences, observations, reading, reflections and questions on a weekly basis.	225 typed pages

Table 5: Summary of data collected

7 Main results

If collaboration is "unabatedly demanding" (Defila and Di Giulio, 2018: 101), what can be done? This phrase repeats, like an insistent pulse ("un / a / bat / ed / ly / de / man / ding") through several of my papers because I see it as *the* core challenge to address, in the field of sustainability research and beyond. Papers 2 and 3 create an overarching narrative for how to think about, design and engage in collaborative interdisciplinary research. This includes adopting strategies to learn to collaborate while collaborating, which incorporates dialogue practices. More fundamentally, it suggests creating conditions conducive to collaboration. Papers 1 and 4 on FAR are wrapped around these, starting with a methodology to study collaborative interdisciplinary research and ending with experiences of having applied this methodology with the Leverage Points team. Furthermore, Paper 4 starts to explore the role that research into research (like FAR) can play in a team to address collaborative challenges and apply a strategy of learning to collaborate while collaborating.

Below follows a summary of each of the four core papers included in this thesis, starting with a synopsis of their correspondence with my overarching research questions, each paper's purpose, the main issue it addresses, the core argument to address that issue and intended contribution.

7.1 Paper 1: Researching collaborative interdisciplinary teams: Practices and principles for navigating researcher positionality

Authors: Freeth, R. and Vilsmaier, U. In review at Science and Technology Studies journal

Corresponds to research question 1: How can a formative accompanying researcher navigate positionality in relation to a collaborative interdisciplinary research team?

Purpose: To propose a way to navigate dynamic positionality in relation to a collaborative interdisciplinary research team.

Issue addressed: Potential for disorientation when adopting dynamic positionality, especially in the context of a complex and messy collaboration (which could distract from, rather than advance, understanding about collaborative research).

Argument: By distinguishing between three FAR learning orientations and using the balancing act practices and principles, a researcher is more likely to keep their bearings while navigating dynamic positionality in relation to the team. As a result, their research is more likely to be useful to the collaborative interdisciplinary team and to advance understanding of collaborative research more generally.

Intended contribution: To contribute to 'research into research' by creating a more nimble approach to dynamic positionality.

Summary

This article lays the methodological foundation for my research, presenting a proposal for the how-to of formative accompanying research. We argue that FAR's distinctiveness lies in its relationship to learning. Whereas most other forms of research into research aim to learn *about*, or *with*, or *for* a team (or other research entity), FAR has the potential to learn *about*, *with* **and** *for* a team, whether in the field of sustainability, or beyond. Movement between learning about, with and for a research team has implications for a FAR researcher's positionality.

Thus the purpose of the article is to propose a way to navigate dynamic positionality in relation to a collaborative interdisciplinary research team that includes:

- Three balancing acts: between observation and participation; between curiosity and care; and between impartiality and investment.

- Three practices which enable navigation of the balancing acts: a practice of dynamic proximity to move between observation and participation; a practice of critical reflexivity to move between curiosity and care; and a practice of embedded relationality to move between impartiality and care.

- Three principles to provide a compass to the navigator: congruence, sensitivity and translucence.

We illustrate this conceptual proposal with three experiences of conducting FAR in the Leverage Points project. Arranged around the troubling theme of research 'intervention' we present three narratives of uninvited intervention, co-created intervention and invited intervention and sift these experiences through the balancing acts approach. This produces a first set of insights into advantages and limitations of our proposed approach to dynamic positionality, and indicates the importance of keeping the tension between the three learning orientations. We conclude by asking whether, with skilful navigation of positionality, FAR can advance collaborative research. I return to the themes of FAR intervention and contribution to collaboration in Article 4.

7.2 Paper 2: Learning to collaborate while collaborating: Advancing interdisciplinary sustainability research

Authors: Freeth, R. and Caniglia, G. Accepted for publication in Sustainability Science journal

Corresponds to research questions 2, 3 and 4: How can the concept of epistemic living space be adopted and adapted to study experiences of collaborative interdisciplinary research? What are the collaborative experiences of researchers in the LP team? What have we learned that could advance collaborative interdisciplinary research?

Purpose: To propose i) a conceptual model for thinking about CIDR and ii) a learning strategy for designing and engaging in CIDR in a way that builds collaborative capacity.

Issue addressed: Researchers, regardless of prior collaborative education or experience, cannot be assumed to possess the full set of necessary skills to deal with challenges of teamwork in interdisciplinary collaborations. Such gaps in collaborative capacity can undermine the experiences and outcomes of conducting research in interdisciplinary teams.

Argument: Thinking about collaborative interdisciplinary research as multidimensional epistemic living spaces, which can be sites of discomfort by virtue of the challenges encountered in them, opens up possibilities for intentionally learning to collaborate. A learning strategy can help to more fully realizing the potential and goals of interdisciplinary collaboration.

Intended contribution: To provide a systematic and comprehensive way of thinking about collaborative interdisciplinary research in order to optimize opportunities to learn to collaborate while collaborating, especially in research for sustainability.

Summary

In the field of sustainability research, inter- and transdisciplinary collaboration are considered essential to researching complex social-ecological systems. Therefore, the gap between the promise of interdisciplinary collaboration and current delivery on that promise is a particularly pressing concern in this field. One of the contributing factors is a lack of collaborative capacity for dealing with the full range of challenges that can arise in interdisciplinary research teams. We argue that predominant ways of thinking about interdisciplinary collaboration, including blind spots to gaps in collaborative capacity, hamper making progress in this regard.

To engender fresh ways of thinking, we draw on Ulrike Felt's (2009) concept of epistemic living spaces to take into account not only the epistemic dimension of a collaboration, but also social, symbolic, spatial and temporal dimensions. This enables addressing collaborative challenges that arise in different dimensions and that can undermine collaboration if not attended to.

We adapt the concept of epistemic living spaces in two ways. First, by talking about *collaborative* epistemic living spaces in order to conceptualize and study an interdisciplinary research team as a single unit. Second, by enlisting the idea of different degrees of collaborative comfort in all five dimensions of an epistemic living space. Thus our conceptual proposal produces a model of collaborative interdisciplinary research as a multidimensional epistemic living space in which researchers encounter varying degrees of comfort and discomfort.

Based on a literature review, we identify eleven key challenges of interdisciplinary collaboration experienced in the five dimensions of a collaborative epistemic living space. Where researchers lack skill to address collaborative challenges, they can be expected to precipitate some degree of discomfort. We draw on the work of Horst (2013), Senninger (2000) and on the theory of experiential learning (Kolb, 1984) to argue for taking advantage of discomfort as a trigger for learning.

On the basis of this conceptual proposal and literature review of challenges, we outline a strategy for learning to collaborate while collaborating. This learning strategy comprises two parts. The first part, which focuses on the whole team as a unit, emphasizes the importance of creating conditions in all five dimensions – epistemic, social, symbolic, spatial and temporal – that foster learning to collaborate. Here, it is important to pay attention to levels of comfort and discomfort when opportunities arise to learn from challenging collaborative experiences. The second part of the strategy, which focuses on individual researchers, emphasizes their responsiveness to taking advantage of such conditions for cultivating collaborative capacity. Returning to the literature review, we identify collaborative capacities a researcher can cultivate to address all eleven collaborative challenges.

Examples from the Leverage Points projects are included throughout the article to illustrate the claims we make about the kinds of challenges encountered in interdisciplinary collaborations, and to ground our conceptual proposal and learning strategy in lived experience.

7.3 Paper 3: Engaging creatively with tension in collaborative research: Harnessing the "I" and "we" through dialogue

Authors: Freeth R., Clarke, E. & Fam, D. 2019. In *Independent thinking in an uncertain world: A mind of one's own*. Brown, V.A., Harris, J.A., & Waltner-Toews, D. (Eds.). London, Routledge (Taylor & Francis Group). Publication date: 31 May 2019

Corresponds with research questions 3 and 4: What are the collaborative experiences of researchers in the LP team? What have we learned that could advance CIDR?

Purpose: To explore the tensions in the "I" – "we" paradox, using a combination of conceptual and empirical research.

Issue addressed: Using binary logic to think about difficulties in collaborative interdisciplinary research makes it more difficult to address these difficulties. Specifically, this article refers to treating independent thinking and individual initiative as irreconcilable with collaborative approaches to collaborative research.

Argument: As levels of problem wickidity, individual initiative and heterogeneity rise in a team, the "I" and "we" tension becomes increasingly taut. Dialogue is a skill to be cultivated to work creatively with such tensions.

Intended contribution: To provide a calibrated approach to engaging with paradox, and the tensions it creates, in a team, from serial monologue to generative dialogue

Summary

This chapter departs from the perspective that individual agency and independent thinking are a prerequisite in research. However, when conducting collaborative research, this creates an apparent contradiction between individual initiative ("I") and collective synergies ("we"). We frame this as a paradox. A paradox is different to a problem, which has implications for how to address it (Bohm, 2004). While a problem suggests that there is a solution, a paradox comprises apparent contradictions that resist solution. Apparent contradictions create tension. While contradictions are inevitable in collaborations, such tensions can cause researchers significant discomfort. If there is no obvious solution, researchers may default to ignoring the paradox or applying binary logic, which risks further polarizing the contradictions. The alternative is to adopt a both / and approach, and engage with the tension as a source of learning in collaboration.

With regard to the "I" – "we" paradox, we argue that both individual agency and collective synergy are important in collaborative interdisciplinary research and we explore implications when the following factors vary in relation to each other:

- The extent of problem wickidity;
- The level of individual agency; and
- The degree of heterogeneity in the team.

We draw on empirical material gathered in the course of conducting formative accompanying research in the Leverage Points projects. Tracing fluctuations in the "I" – "we" paradox over the course of three annual team retreats gives insight into the difficulties of balancing individual scholarship priorities with the need to maintain collective coherence in a team. Attempts to dissipate tension are unlikely to eliminate the underlying paradox, which is an endemic feature of collaboration. An alternative is to engage creatively with the tension through dialogue. The chapter concludes with four different ways of engaging with high levels of tension caused by paradox: serial monologue, engaged monologue, reflective dialogue and generative dialogue. This approach to a dialogical research practice can be applied to the tension produced by any of the paradoxes, false dichotomies, or polarized differences encountered in collaborative interdisciplinary research.

7.4 Paper 4: Advancing collaborative interdisciplinary research for sustainability: Learning about, with and for a research team

Author: Freeth, R. Submitted to Journal of Cleaner Production

Corresponds with research questions 1, 3 and 4: How can a formative accompanying researcher navigate positionality in relation to a collaborative interdisciplinary research team? What are the collaborative experiences of researchers in the Leverage Points team? What have we learned that could advance collaborative interdisciplinary research?

Purpose: To reflect on and learn from my experience of FAR as the project draws to a close. This article focuses on the team's response to and engagement with FAR.

Issue addressed: In the absence of a clear learning strategy (following Paper 2), or conducive conditions, researchers in collaborations may not be in a position to benefit from *in situ* learning opportunities presented by the presence of a formative accompanying researcher.

Argument: From a methodological perspective, FAR requires skilful navigation of positionality. However, for FAR to be effective as a practice – i.e. to contribute to advancing collaboration in an interdisciplinary team - also requires the team's active engagement with FAR. I call this relational learning. This implies engagement between a formative accompanying researcher and a team in processes and outcomes of learning about, with and for the team. It requires certain conditions be in place so that researchers can take advantage of opportunities to learn with FAR and to take ownership of FAR learning interventions conducted on their behalf.

Intended contribution: To inform how academics who design and implement collaborative interdisciplinary research projects can foster conditions to take advantage of research into research for advancing collaboration. This adds further possibilities to enacting a learning strategy proposed in Paper 2.

Summary

This final article, written at the end of my research, complements the first article on the FAR methodology. Where the first article mooted a conceptual approach to practicing FAR, this final article reflects on experiences of practicing FAR. Where the first article emphasized FAR positionality, this article emphasizes FAR relationality. Accordingly, where the first article focused on the formative accompanying researcher in that relationship, this article focuses on the collaborative interdisciplinary team and their response to FAR.

Specifically, this article is organized around team engagement with the three FAR learning orientations: learning *about*, *with* and *for* a team. Being learned *about* was the more familiar orientation to the research team, and they engaged with a refreshing degree of openness. As a result, I learned much *about* the rewards and difficulties of interdisciplinary collaboration. Opportunities to learn *with* a formative accompanying researcher received a more mixed response. Over time, several individuals in the team demonstrated growing awareness of, and interest in, how the collaboration was unfolding. However, at a team level, there was ambivalence to reflect and learn together due to time constraints as well as hesitation to talk in the full team about difficulties and disappointments. As a result, there was limited collective experiential learning about collaborative research. Following from this, there was limited response to opportunities of being learned *for*, particularly if that had the character of being helped. In the last year of the project, I was asked to contribute to integration of the team's research. Officially, this was not in my FAR capacity, although it proved confusing to keep this contribution entirely separate.

FAR was a novel approach for the team and conditions were not fully in place to foster experiential learning, or to jointly identify interventions on the basis of insights gleaned from experiential learning. Therefore, this article ends with recommendations to researchers responsible for initiating and implementing collaborative interdisciplinary research projects and who wish to foster learning with the support of FAR.

8 Synthesis & implications

8.1 Synthesis

I provide a brief overview of my research outcomes in the form of a table organised to demonstrate how each outcome responds to a research question and addresses a research objective. Table 6 therefore synthesises the main outcomes of my research, which are presented in detail in the four core papers that constitute Chapters 2 to 5 of this thesis and the two supplementary papers that constitute the appendices.

In the remainder of this section, I explore implications arising from my research findings, starting with a discussion related to collaborative interdisciplinary research, followed by a discussion related to formative accompanying research. I end with indications of where future research could lead and reflections on what I have learned as a researcher.

Research objectives / Research questions	Objective 1: To develop FAR methodology	Objective 2: To investigate a conceptual framework to study collaborative teams	Objective 3: To study researchers in sustainability	Objective 4: To advance collaborative interdisciplinary research practice/s
Q1: How can a FAR researcher navigate positionality in relation to a collaborative interdisciplinary research team?	Developed an approach to navigating positionality (Paper 1/Chapter 2). Learned about difficulties of maintaining fluid positionality over the long term (Paper 4)	Proposed FAR to track learning in collaborations, conceptualized as multidimensional spaces in which researchers experience different degrees of dis/comfort (Paper 2)	Used FAR model as a heuristic to inform ongoing study of experiences of the Leverage Points project in the field of sustainability (Paper 1)	Developed recommendations for strengthening FAR in future studies of interdisciplinary collaboration (Paper 4)
Q2: How can the concept of epistemic living spaces (ELS) be adopted and adapted to study experiences of collaborative interdisciplinary research?	Adopted ELS to organize and analyse FAR data through five dimensions (Paper 2)	Adapted ELS concept to 'collaborative epistemic spaces' to study a collaborative team as a unit (Paper 2)	Adapted ELS dimensions to study research experiences in the field of sustainability (Paper 2)	Adapted ELS to combine five dimensions with zones of comfort and discomfort, to advance CIDR through a learning strategy (Paper 2)
Q3: What are the collaborative interdisciplinary experiences of researchers in the Leverage Points team?	Learned about relational quality of FAR: learning with and for the team requires active engagement (Paper 4)	Applied experiences in Leverage Points to illustrate collaborative challenges in five dimensions of an epistemic living space, and how to address such challenges through a learning strategy (Paper 2)	Explored paradox and tension between "I" and "we" in collaborative research for sustainability, illustrated by experiences of the Leverage Points team (Paper 3)	Drew on experiences in Leverage Points to demonstrate possibilities to strengthen dialogical research practices in collaborations more broadly (Paper 3)

Q4: What have we learned that could advance collaborative interdisciplinary practices?	Positioned FAR within a burgeoning field of research into research for deepening interdisciplinarity. Recommended conditions for such research to advance collaboration (Paper 4)	Framed cultivation of collaborative capacity in all five ELS dimensions to advance research practice. Argued that cultivating collaborative capacity is relevant regardless of researchers' former collaborative education or training (Paper 2)	Proposed conceptual framework to address neglect of 'inner worlds' in the field of sustainability research. Proposed research agenda to strengthen inside-out sustainability (Paper 5)	Proposed that researchers build tolerance for increasing levels of heat (emotion, conflict, sense of urgency) in collaborative interdisciplinary research (Papers 2 and 6)

Table 6: Synthesis of research outcomes
in relation to research questions and research objectives

8.2 Advancing collaborative interdisciplinary research: Three deep enablers

The overall aim of my research inquiry is to support the advancement of collaborative interdisciplinary research. In my introduction to research results (section 7 of this chapter), I referred to an overarching narrative for how to think about, design and engage in collaborative interdisciplinary research. Here I use this narrative structure to assemble insights about three interconnected enablers. At the heart of this discussion are two riddles that have been teasing the team in the Leverage Points project, including me in my role as a member of the team. One is about paradigms as deep sources of leverage. The second is that in collaborative research, there "may be enduring, endemic tensions …[that] admit no universal resolution." (Hackett, 2005: 820). Following Bohm (2004), the question is how to stay with the paradoxes that create these enduring tensions, instead of either polarizing in the face of them, or flattening them into problems to be solved.

Ways of thinking about collaborative interdisciplinary research: Hold a meta-perspective

A collaborative research project is busy and noisy, consuming attention with daily demands. As team members, it is easy to get swept up in the detail, fully engaged with the visible and expressed life of a project. Part of a leadership role in collaborations is to hold the big picture and to see the connections (Griffin and Stacey, 2005; Strober, 2011). However, in the current research environment, senior academics are expected to work across multiple large projects while raising resources for the next projects. Even with the

best intention and skill, leaders are distracted by their multiple academic responsibilities from being able to consistently hold a meta-perspective in demanding research collaborations. In part, it was in recognition of the importance of holding such a perspective that the Leverage Points project created the formative accompanying researcher role. Papers 1 and 4 propose that, under the right circumstances, the presence of a formative accompanying researcher can bring a complementary meta-perspective to that held by leaders and other individual members of a team who are interested to learn *with* a formative accompanying researcher.

Holding a meta-perspective helps to reframe difficulties, discomforts and differences that are inescapably part of collaborative work. The point is to be able to think about them, as opposed to denying them, so that they can act as sources of understanding and catalysts for change. As Paper 5 in Appendix 1 argues, framing relates to deep beliefs and the language used, sometimes unconsciously, to express them (Lakoff and Johnson, 1980). According to Meadows (2008: 174) "our mental models are mostly verbal" which requires us to "use language with care". Thus a change to the framing of collaborative challenges, and the words we choose to communicate them, could be a deep leverage point, including in interdisciplinary collaboration (Bracken and Oughton, 2006).

When faced with seemingly overwhelming *difficulties,* distinguishing between different dimensions (including epistemic, social, symbolic, spatial and temporal dimensions) can help to more clearly frame and articulate obstacles to progress (Paper 2). A next step is to perceive interconnections between the different dimensions. Turning difficulties over in the mind can also allow for re-evaluating any sense of *discomfort* that they might have activated (Papers 2 and 6). Under supportive conditions that enable experiential learning, a certain degree of discomfort can be a source of reflection and change the ways in which we think about them. Lastly, experiences of *difference* can be reframed. Diverse ways of addressing research questions, or diverse temperaments in a team may provide clues to complementary ways of working together, rather than as sources of conflict, competition or incompatibility (Paper 3). This is not to suggest that conflict should be avoided on principle, but to propose discerning between tensions that are inherent to collaboration and deserve meta-perspective awareness, and tensions that deserve heated debate in order to get underneath unhelpful complacencies (Paper 6 as well as Papers 2 and 3). This means paying attention to what is implicit.

Ways of designing collaborative interdisciplinary research: Pay attention to what is implicit

Threaded through all six papers, but most evident in Papers 3, 5 and 6, is the idea that what is apparent on the surface of the daily life of an interdisciplinary research team is a manifestation of underlying and often unacknowledged conditions, dynamics, emotions and tensions. My conceptual and empirical work indicates that collaborative research is enriched when these receive attention. Underlying conditions that foster collaboration (and efforts to enhance collaboration) deserve attention from the point when a project is first conceived. Underlying dynamics, emotions and tensions represent a particularly useful source of information and understanding when a team experiences difficulties. If a team is conscious of its collaborative challenges and wishes to learn from them in order to change, these underlying aspects represent opportunities to identify deep sources of leverage for change. In particular, the deep goals and paradigms "out of which the system arises" may be found here (Meadows, 2008: 162).

Somewhat mischievously, Meadows (2008) proposed that *transcending* paradigms is the deepest leverage point. Czarniawska (1997: 177) suggests that "paradox is an enemy of paradigmatic ways of knowing". I would argue that the uncomfortable experience of not-knowing when working with paradox, makes it more possible to suspend paradigms, and possibly even transcend them. This prompts another look at the practices proposed in Paper 3, of engaging creatively and collectively with paradox in teams. Continuing to think with Czarniawska (1997: 177), who claims that paradox can endure within narrative, there is much value in using narratives in teams to explore the paradoxes and allow them to reveal paradigms. This has been an attraction of using narrative approaches to interviewing members of the team, presenting initial findings to the team, and presenting research outcomes to a wider audience. Paradoxes can be "delicious" (Holling and Gunderson, 2002: 40), resisting simplistic resolution, but with patient attention allow for discovery of the invisible "common source" out of which paradoxes arise (Smith and Berg, 1987: 45). 'Generative dialogue' (Paper 3) has a role to play in doing this collectively.

Ways of engaging in collaborative interdisciplinary research: Towards flourishing

While I consider leaders to be primarily responsible for creating conditions conducive to collaboration, all members of a collaborative team are responsible for how they engage in the team. Papers 3, 4 and 5 identify the importance of engaging with self-awareness. Self-aware researchers are a valuable resource to their teams because they know what they do well and what they do not yet do well, and tend to be motivated to take responsibility for addressing such gaps by continuing to strengthen their collaborative knowledge and skills (Paper 2). High levels of self-awareness in a team make it more possible to harness

complementarities between differences and to move from ‘engaged monologue’ into ‘reflective dialogue’ to explore underlying assumptions and apparent contradictions (Paper 3).

Another way of engaging in collaboration relates to perceiving the temporal dimension of a collaborative epistemic living space (Paper 2). Collaborative research projects cycle through different phases of activities and tasks (e.g., Jahn et al., 2012; Lang et al., 2012). I noticed that members of the Leverage Points team also experienced collective motivational cycles, which seemed to indicate undercurrents of emotion over the lifespan of a project, such as initial excitement, disillusionment, adaptation, and recommitment (Paper 6). This appeared to track project cycles, as well as be a consequence of the particular rigours of working in the field of sustainability.

For sustainability researchers, it is hard to remain optimistic when constantly exposed to data and discourses about climate change trajectories or anthropogenic impacts on ecological systems (Goldberg, 2012; Hoggett and Randall, 2016). There is an argument that working creatively with the disruption wrought by such emotions is necessary and appropriate in this field (Kingsnorth and Hine, 2009). But to engage with such disruption collectively requires a sophisticated level of collaborative capacity. In the Leverage Points project, we managed to do this occasionally, talking about frustrations and disappointments related to project cycles as well as the bigger issues of sustainability. Resisting such feelings seemed to require more energy than acknowledging them, and prevent the team from learning what might have provoked these feelings in the first place (Papers 3 and 6). Following poet David Whyte (2015), a way of engaging with collaborative research is to turn towards, rather than away from, disappointment because:

“To be disappointed is to reappraise not only reality itself but our foundational relationship to the pattern of events, places and people that surround us, and which, until we were properly disappointed, we had misinterpreted and misunderstood … “

Rabinow (2011: 207), fresh from his (mis)adventures of belonging to, researching and being disappointed by a collaborative interdisciplinary project, invokes the possibility of a “flourishing existence” in research: “Understood most broadly, flourishing includes physical and spiritual well-being, courage, dignity, friendship and justice, although the meaning of each of these terms must be reworked and rethought according to contemporary conditions.” For the purposes of my research, this provokes a final question: what is the role of a formative accompanying researcher to inquire into and support a kind of flourishing that is meaningful to the team they researching?

8.3 Learning from FAR: Positionality and relationality

A formative accompanying researcher committed to learning about, with and for a team, can be a resource to a team that wants to learn in order to enhance their collaboration. Specifically, a FAR role can support a team to return regularly to a meta-perspective, pay attention to what is implicit and engage with disruptions. Alternatively, through clumsy navigation of positionality and relationality, a formative accompanying researcher could hinder collaboration and learning in a team. Paper 1 of this thesis deals primarily with the question of positionality and Paper 4 focuses on relationality. Figure 5 presents FAR positionality and relationality together; illustrating how navigation of the three balancing acts enables a formative accompanying researcher to study a collaborative interdisciplinary project from multiple perspectives. Moreover, moving along all three balancing acts enables a researcher to take account of the three dimensional character of a collaborative project, embedded in a particular research field and deeper conditions. In the following discussion, I identify insights and implications derived from practicing FAR in this way over a period of three years.

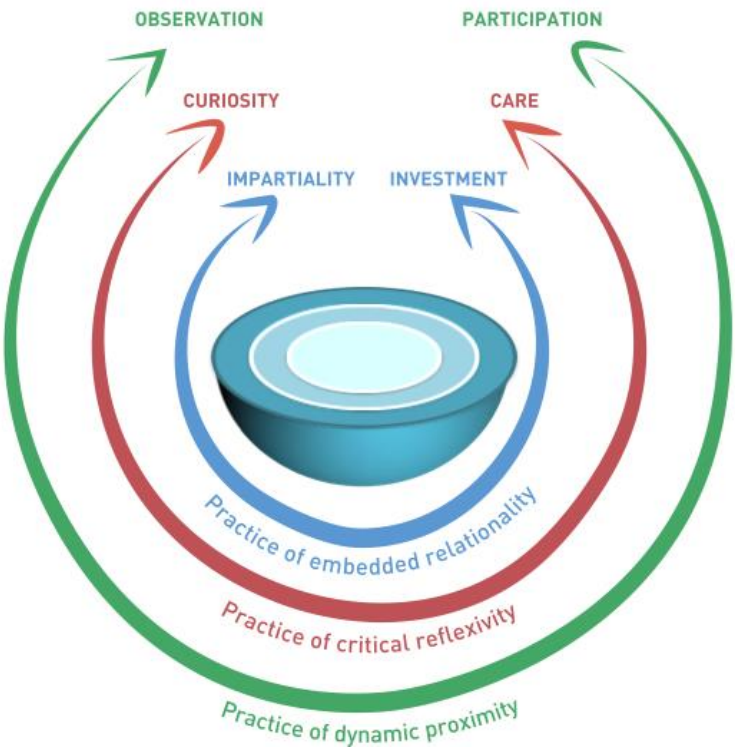

Figure 5: The three balancing acts and practices of FAR positionality
in relation to a three-dimensional collaborative interdisciplinary research project.

Positionality: On getting fixed in a position over time

A defining characteristic of FAR, as we have conceptualized it, is that it is constituted in movement (Paper 1). I discovered that at the beginning it was easy to move fluidly along each of the balancing acts, and between the positions implied by learning about, with and for a team. Over an extended period of researching the same team, it became much more difficult to maintain this degree of mobility. Several factors inhibited my movement over time, such as care trumping curiosity during difficult times in the team, and becoming increasingly invested in particular project outcomes and a change in office allocations, which brought me into closer physical proximity to the team. Over time, my sense of belonging within the team grew. Despite straddling two organisational structures within the university (the Leverage Points project and the Centre for Methods), I found myself increasingly attached to my identity as a Leverage Points team member.

Thus, of all three practices, it was the practice of embedded relationality that proved most testing. This practice is intended to maintain a balance between impartiality and investment. In Paper 1, we (Freeth & Vilsmaier) state that a practice of embedded relationality is about dealing with the consequences of scientific presence (rather than the charade of scientific invisibility), of being implicated in "webs of connection" (Haraway, 1991: 191) and of acknowledging power in relationship. I pick up the experience of working with these dynamics next.

Relationality: On reciprocity, power, intervention and ownership

Dynamics of power are always present in the relationship between a researcher and the researched, and these dynamics are amplified in the case of intervention. Papers 1 and 4 both tackle the question of intervention by a formative accompanying researcher. Acknowledging the ubiquity of power, I was interested in exploring ways to distribute it differently. In Paper 1, this takes the form of a narrative of co-created intervention, which has a different flavour to an intervention initiated by a formative accompanying researcher, whether or not a team has invited it on their behalf. The matter of ownership of an intervention is key. Resistance to intervention is another way in which a team can claim power in this relationship, as discussed in Paper 4. While it can be frustrating for a formative accompanying researcher to observe and do nothing, it can also be counterproductive to intervene without the team's authorisation and ownership of that intervention.

Table 7 summarizes the implications of Papers 1 and 4 for a reciprocal relationship between formative accompanying researcher and a collaborative team. The relationship

in this case is filtered through the three learning orientations (learning about, with and for a team). Callard and Fitzgerald (2015) argue that in interdisciplinary collaboration, power is usually asymmetrical, which renders reciprocity of relationship a myth. While I agree with the first part of their argument, I disagree with their conclusion. In presenting this summary, I assume that reciprocity does not necessarily imply or require symmetry of power relations. I suggest this is the case whether the relationship is between researchers in a team (in their case, in an interdisciplinary neuroscientific project), or between a formative accompanying researcher and the team.

Learning orientation	**Relational implications for collaborative research team**	**Relational implications for formative accompanying researcher**
Learning about	Radical openness to long term scrutiny	Sustained curiosity Balance of curiosity and care
Learning with	Conditions that support learning to collaborate while collaborating Reflexive curiosity about experiences of collaborating, both rewarding and challenging Team environment that supports collective reflexive dialogue Active engagement by individuals with FAR data	Commitment to shared practices of interpreting FAR data in the interests of more nuanced understanding of team experiences Willingness to learn with individuals, sub-teams and the full team, - i.e., where there is interest
Learning for	Identification of opportunities for FAR to 'help' – e.g. arising from engagement with FAR data Active engagement with resulting strategies to cultivate collaborative capacity.	Knowing when to intervene and when to wait Commitment to co-creation of learning for interventions Capacity to see the iterative relationship between learning for and learning about

Table 7: FAR and a collaborative interdisciplinary research team

Relational experiences of learning about, with and for in relationship

These insights and their implications raise new questions about practices of FAR and collaborative interdisciplinary research.

8.4 Future research

We have only just begun to embark on a research agenda to learn about the FAR methodology on its own terms, and that employs FAR methods to learn alongside collaborative research teams. There are multiple directions that this work can take from here. Colleagues at Leuphana University are continuing to investigate different ways of conceptualizing and practicing FAR in collaborative inter- and transdisciplinary teams.

The fact that this thesis does not evaluate the successfulness of the Leverage Points project could be perceived as a limitation. FAR is not a form of evaluation research. Defila & Di Giulio (2018: 102) in their capacity as accompanying researchers, and also studying collaborative research projects, assert that accompanying research and evaluation "should be treated as mutually exclusive outcomes." However, there is work still to be done to reflect on and write up my empirical research in the Leverage Points project. The narrative is incomplete. More distance is required. I look forward to completing the papers currently in progress, and to identifying new themes to analyse. At the same time, an ex-post analysis of FAR will be conducted as the Leverage Points project closes. This will enable learning about the effects of creating a FAR role in the project, and how to practice FAR in future. It should also shed light on the kinds of skills a formative accompanying researcher requires in order to play their role effectively. This introduces a next question to explore: where does this role end? There is a risk that such a researcher falls into the role of team therapist by virtue of the kind of access to confidential information gained over sustained work within a team. Further research could explore boundaries to the role and skills for managing these boundaries.

With regard to collaborative interdisciplinary research, a future avenue of research will be to investigate the particular dynamics of team research in the field of sustainability. There is a relatively large STS body of work on interactions between synthetic biology and the social sciences (e.g., Balmer et al., 2015, 2016) and between the neurosciences and social sciences (e.g., Callard and Des Fitzgerald, 2015). Science of team science has amassed considerable knowledge about research conducted in collaborative healthcare teams. Much more can be learned about collaborative sustainability research, both inter- and transdisciplinary, that would promote its effectiveness.

8.5 My learning as a researcher

Over the course of my PhD work I have learned to combine holding tight with letting go. My work started with expansiveness; thinking, observing, reading with as few filters as possible. Once I had a clearer idea of my research questions, I found value in being very

precise, methodical and systematic. This helped me to identify the co-ordinates to orientate my research practice, create heuristics and frameworks that helped me to think more clearly in the midst of the "mess" (Law, 2004) of information, noise and uncertainty. The five selected dimensions of an epistemic living space helped me to be rigorous. The numerous tables in this thesis are an artefact of my 'holding tight' approach, included here with the intent to share my findings in a systematic and comprehensive fashion. A future goal is to learn how to make this kind of work visible in more accessible ways.

At some point in this research process, it would become clear to me that I needed to expand again. As a researcher, this meant unfurling into poetry, creative non-fiction, conversations in nature with colleagues. Pausing the busyness, blurring the columns and the rows, sometimes losing track altogether. This enabled me to access the kind of creativity that can flow from rigor, and to move from description and analysis into a deeper understanding. To express this understanding required different language. My inclusion of poetry and Appendix 2 "Burning to be understood" in this thesis is an attempt to express the letting go phase in this research cycle, as preparation for a next phase.

9 Conclusions

"*… one must distinguish between science and the practice of science. Science is an ideal, a conception of logical laws acting in the world and a set of tools for discovering those laws. By contrast, the practice of science is a human affair, complicated by all the bedraggled but marvellous psychology that makes us human*." (Lightman, 2005: 36–37).

In this thesis, I focus on myriad ways in which the practice of science is indeed a human affair. My intent is to deepen an appreciation for (bedraggled but marvellous) ways of being human in science that contributes to how we collaborate in practice. To this end, my research has focused on a methodology and practice of FAR with collaborative teams, and on concepts and practices of collaborative interdisciplinary research itself. The outcomes of my research consistently emphasized the significance of learning and of fostering conditions for learning.

Together with Ulli Vilsmaier, I developed a methodology for studying collaborative interdisciplinary research teams that initiates an approach we have called formative accompanying research (FAR). Our work serves as a foundation for further elaboration of FAR. On the strength of this methodological work, I have reflected on three years of practicing FAR, especially in terms of its potential to advance collaborative interdisciplinary research. I found the practice of 'embedded relationality' in the trilogy of FAR balancing acts to be a critical factor in terms of being able to contribute to collaborative interdisciplinary research. As a result, I developed recommendations for

creating conditions that support learning about, with or for a team. The purpose of these conditions is to enhance relational learning between a formative accompanying researcher and a team. Such conditions complement the initial practices and principles of the FAR methodology so that both parties involved in relational learning are ready to engage, in the interests of advancing practices of interdisciplinary collaboration. The FAR methodology and practice will continue to be explored and strengthened at Leuphana University.

With regard to collaboration, I outlined an alternative way of thinking about collaborative *interdisciplinary* research that bypasses some of the impediments of that term, drawing especially on the concept of epistemic living spaces. This reframing supports taking more systematic account of the multidimensionality of collaborative experiences, including challenges, and making sense of associated discomforts. I argued that, with this awareness, researchers would be in a position to use discomfort as a basis for learning to collaborate in a more rewarding fashion. I proposed an experiential learning strategy for those who initiate, design and conduct interdisciplinary research to create and take advantage of conditions for learning to collaborate while collaborating.

With co-authors, I proposed a way of thinking about the perennial collaborative tension between “I” and “we” that makes the best of both, especially when dealing with highly complex sustainability issues in highly diverse teams. I revised an existing model of talking and listening (Kahane, 2017; Scharmer, 2008) so that it would especially apply to the academic context and focus on how to work creatively with paradox and tensions in interdisciplinary collaboration. The intention of refining this model is to encourage teams to acknowledge tensions rather than dismiss them, and to make it intellectually worthwhile to tolerate paradox.

Zooming out, I made an argument for recognising tacit and invisible aspects of collaborative experience, at multiple scales: the inner life of individuals, dynamics of a team and conditions of a project, as well as being cognisant of how global patterns of (in)justice and privilege are present in how we do our research together.

The privilege of researching the Leverage Points team for more than three years has been an experience of being a participant observer in a profoundly human affair. The project’s aspirations were immense, which follows from the seduction of writing competitive research proposals for third party funding. We could only fall short of realizing these aspirations. The question then is not whether we are fallible humans - this should be a foregone conclusion - but what we do with our fallibility? Here I include myself and my fallibility. Can we acknowledge it, to ourselves or with our colleagues? Most importantly, can we learn from it? Can these experiences create enough discomfort, but not too much,

to kindle the desire to dig deeper into our assumptions and their associated feelings, in order to keep learning to collaborate? The skills for doing so are already there, lively curiosity, disciplined analysis, a disinterest in superficial discovery. Part of the trick, as researchers, is to turn these skills on ourselves.

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CHAPTER 2

RESEARCHING COLLABORATIVE INTERDISCIPLINARY TEAMS: PRACTICES AND PRINCIPLES FOR NAVIGATING RESEARCHER POSITIONALITY

Rebecca Freeth & Ulli Vilsmaier

ABSTRACT

Collaborative interdisciplinary research is on the rise but can be difficult and daunting. There is much to learn by studying the inner workings of collaboration, to the potential benefit of both science and technology studies (STS) and those who collaborate. We have been studying the inner workings of a collaborative interdisciplinary team using formative accompanying research (FAR). Assuming multiple insider-outsider vantage points implied adopting dynamic positionality in relation to the team. In this article, we outline an approach to navigating positionality based on these research experiences. Navigation is aided by identifying learning orientations to a collaborative team, to learn about, with or for the team; and by adopting practices and principles to balance competing demands between i) observation and participation; ii) curiosity and care; and iii) impartiality and investment. We illustrate what we have learned so far, demonstrating how these navigating instruments can work in practice.

1 Introduction

The proliferation of collaborative interdisciplinary research is well documented (e.g. Klein 2015; Stokols 2014). By collaborative interdisciplinary research, we mean research conducted through teamwork that integrates two or more disciplines or fields of knowledge (National Academy of Sciences, National Academy of Engineering, Institute of Medicine, 2005; Pfirman and Martin, 2010). Indeed, such is the contemporary appeal of interdisciplinarity that Jasanoff has portrayed it as "the new Canaan, the promised land where ailing scholarly traditions go to be reborn and academic creativity is set free." (2013: 99). However, it remains difficult to translate aspirations of productive and meaningful interdisciplinary collaboration into successful research projects (Darbellay, 2015; Strober, 2011; Weingart, 2014). Barriers to success range from the institutional and administrative to the interpersonal and emotional (Fitzgerald et al., 2012; Klein, 1990).

At the interpersonal level, epistemic and social difficulties can arise from the complexity of dealing with high levels of heterogeneity. Members of an interdisciplinary team are tasked with integrating different research goals, research methodologies and types of knowledge, which involves working across different disciplinary cultures and working styles while engaging with plural quality criteria, value systems and norms (Boix Mansilla, 2006; Hampton and Parker, 2011; Strober, 2011). Thus it is unsurprising that there is considerable ambivalence with regards to collaborative interdisciplinary research – what Padberg (2014: 96) refers to as "reservation" and Ledford (2015: 309) as "resistance". Ambivalent team members constitute an additional difficulty, sending mixed messages that can foster confusion and inertia in collaborative teams. In sum, there is a tension between assumptions on the one hand that interdisciplinary collaboration can address the complexity of contemporary research questions and thus deserves considerable investment of time, effort and funds (e.g., Gleed and Marchant, 2016) and, on the other hand, the myriad barriers and uncertainties faced when engaging in such collaborations.

Considerable research attention has already been paid to learning about collaborative interdisciplinary research and to advancing it. However, there is relatively little research on the inside, lived experiences of interdisciplinary collaboration (Callard et al., 2015; Mauthner and Doucet, 2008), where interpersonal difficulties manifest (Barry and Born, 2013). For example, Fitzgerald et al. (2014: 701) note that the field of science and technology studies (STS) has not given much account of "what it is actually like to participate in such a research space." However, when reading the few accounts that do exist, such as that of Fitzgerald et al.'s own research within a collaboration between the neural and social sciences (2014), it is difficult at times to discern whether they are describing their experiences as STS researchers or those of the collaborative team they

were studying. Indeed, STS investigations into the lived experiences of collaboration can create enmeshed "… obligations, concerns, loyalties, friendships, contradictions, hopes and fears" (Balmer et al., 2015: 9), particularly if there is a shared interest in the research topic. The result is that a researcher who moves between the inside and outside "can lose her sense of herself" (Humphrey, 2007: 23) and, we would add, lose track of her positionality in relation to the team. The possibility of becoming disorientated is particularly strong in the complexity and "messiness" (Cosley et al., 2014) of a large collaborative interdisciplinary project, which suggests the benefit of developing clearer methodological guidance.

We introduce a methodology we are using to conduct research in a large collaborative interdisciplinary project. This methodology, called formative accompanying research (FAR), is committed to promoting knowledge about collaboration while promoting the practice of collaboration. The first author is conducting FAR as a member of the collaborative team, supported by the second author. The authors have been working with collaborative teams over many years, facilitating, co-ordinating, collaborating with and accompanying inter- and transdisciplinary research projects. When taking on certain of these roles we experienced advantages of being mostly outside the core team. But we also identified the limitations of lacking a deep understanding of the challenges and difficulties that are faced inside collaborative teams. Drawing on these experiences, we developed and implemented FAR, operating on the assumption that being on the inside offers a deep vantage point to experience the inner workings while explanations about the mechanisms of such collaborations benefit from the distance afforded by moving further away.

In this article, we propose navigating insider-outsider researcher positionality by 1) distinguishing between different research orientations in relation to the collaborative team: learning *about*, learning *with* or learning *for* the team; 2) identifying a series of balancing acts and related practices to enable a researcher to retain balance while responding to competing demands; and 3) following three anchoring principles: congruence, sensitivity and translucence. Learning *about* has the epistemic goal to create transferable results, pursued in the role of scientific researcher. Learning *with* has the goal to learn alongside the team, in the role of a team member. Learning *for* has the goal of supporting the team to advance its research outcomes, in the role of an intervener. Through this proposal, we intend to contribute to the broader field of "research into research" (Guattari, 2015: 135), by creating a sure-footed approach to dynamic positionality that can advance collaborative interdisciplinary research.

To make this proposal, we start by introducing FAR in relation to neighbouring methodologies and the Leverage Points for Sustainability Transformation collaboration in

which we have applied it. Then we outline the methodology itself in terms of its approach to dynamic positionality and the balancing acts that this involves, and present a series of practices and principles to navigate those balancing acts. Using examples from our experience, we demonstrate how this approach can work as a heuristic for navigating dynamic positionality and identify modest initial successes as well as pitfalls. The article ends with prospects for further investigation.

2 Locating formative accompanying research

FAR can be located in relation to other, neighbouring, methodologies that learn about, with *or* for projects. We start with the two at the core of the FAR terminology – i.e. formative research and accompanying research. Accompanying research is a direct translation of *Begleitforschung* in the German-speaking context. However, *Begleitforschung* refers to an amorphous range of research activities, broadly studying the impact of technology, and is most directly comparable to ethical, legal and social implications research (ELSI) (Fiedeler et al., 2010). In a bid to address the semantic and methodological confusion, Defilia and Di Giulio (2018) have proposed a typology for accompanying research, which differentiates complementing, meta and integration-oriented types. Using this typology, the distinguishing feature of FAR is that it can move between all three. Formative research runs contemporaneously with a (research or other) project, generating information to trigger ongoing reflection and adjustment. It aims to strengthen project design and implementation through iterative cycles of feedback and learning (Reigeluth and Frick, 1999; Chen, 2010). The possibility to not only learn *about*, but to learn *with* and *for* a collaborative team gives FAR opportunities to play a formative role, helping to shape a collaborative project while there is still malleability in its design. It is also here that the potential to advance collaborative interdisciplinary research lies, at the micro scale of the project. None of the existing descriptions of accompanying or formative research capture the idea of research positionality constituted in movement, between insider and outsider roles as proposed in FAR.

FAR can also be considered in relation to methodologies designed to research and promote interdisciplinary collaboration, such as Socio-Technical Integration Research (STIR) (Gjefsen and Fisher, 2014) and the Toolbox Dialogue Initiative (O'Rourke and Crowley, 2013). What they have in common with FAR is an appreciation of the value of "interactional expertise" (Collins and Evans, 2002) in collaboration – i.e., the capacity to engage meaningfully across disciplinary and other differences in academic environments. However, their strategies are intervention-oriented, to remedy largely predefined problems of collaborative interdisciplinary integration (Fisher et al., 2015) as opposed to

FAR's slower and more exploratory emphasis on learning *about* and *with* a collaboration prior to considering possibilities to learn *for.*

FAR bears similarities to, and is distinguishable from, embedded research (e.g., Hackett and Rhoten, 2011) and ethnographic research (e.g. Beaulieu, 2010). Like embedded research, FAR foregrounds the advantages of being positioned within the project being researched. However, embedded researchers tend to be temporary sojourners, having a primary research home elsewhere, and their research has pre-formulated and instrumental outcomes – such as strengthening the efficacy of health systems (Olivier et al., 2017). By contrast, a formative accompanying researcher remains *in situ*, anticipating a strongly emergent flavour to learning outcomes. While FAR does not share the sociological or anthropological disciplinary roots of most ethnographic research practices, it gains from a rich ethnographic tradition of research into research. and this article aims to contribute further insights into the "chameleon"-like qualities (Balmer et al., 2015: 16) of an ethnographic STS researcher.

We locate FAR within the field of STS, acknowledging the diverse sources of intellectual inheritance on which STS draws (Jasanoff, 2013). A FAR approach is intended to slip free of the ethical, legal and social implications (ELSI) era of STS and thus avoids joining the ranks of "humourless, joyless … handwringers" bent on keeping science accountable (Balmer et al., 2015). Instead, FAR aligns well with the post-ELSI approach to STS, which seeks to be more intimately engaged and constructive, with the aspiration that "…'working with' scientists and getting further entangled could help to produce novel and more diverse forms of objects *and* knowledge for *all* participants." (Balmer et al., 2015). This accords well with what the European Science Foundation notes as the emergence of a *self-consciously interdisciplinary practice* within the modern academy." (Fitzgerald et al. 2012:11 emphasis added). An example of more self-consciously interdisciplinary research is the Leverage Points for Sustainability Transformation project.

3 The Leverage Points collaboration

The Leverage Points project aims to critically examine deep leverage points for sustainability. Inspired by the work of Donella Meadows (2008), it focuses on three realms of leverage: re-structuring institutions, re-connecting people with nature and re-thinking knowledge production for sustainability (https://leveragepoints.org; Abson et al. 2016). The project initiators conceived of a FAR role within the team from the outset. The international team consists of 23 researchers from multiple disciplinary and interdisciplinary backgrounds spanning the social and natural sciences, as well as law, engineering and design. The Leverage Points project is a case of "functional

interdisciplinarity" characterised by "data exchanges and common epistemological approaches linking different disciplines and framing integrated research projects" (Whatmore, 2013: 166–167). Co-locating all the researchers at Leuphana University, Germany, facilitates day-to-day collaboration. Deeper integration is attempted through combining conceptual work with empirical research and transdisciplinary case studies. When the project was initially conceived, it was decided that one of the 23 researchers would study the team itself, in order to deepen understanding of interdisciplinary research practices and use this understanding to enhance the ongoing team research process. The title given to this role was formative accompanying researcher. The formative accompanying researcher (Freeth) has been provided with two offices. One is co-located with the Leverage Points team and the second is under the auspices of the Methodology Centre, where FAR has been developed.

4 Navigating positionality: Balancing acts and practices

What we miss in much of the STS work as well as other ways of studying collaborative research, such as science of team science (SciTS), is an approach that does methodological justice to the complexity of the research situation being studied. Given that FAR is constituted on the move, we are seeking ways to work with the complexity in a methodologically sound way. For this, we draw on Haraway's (2004: 5) argument in favour of creating "situated accounts", which involves being "in the action… finite and dirty, not transcendent and clean" (1996: 439), without getting lost in the action. Our approach to FAR is based on how this theoretical stance could apply in practice, providing guidance rather than guidelines. Organizational scholar Czarniawska (1997,177) notes that, as researchers, "…we generally remain blind to our own role and position." If this is true for research in general, how much more significant is it that research into research makes its positionality explicit, particularly when studying collaborative interdisciplinary research? However, Balmer et al. (2015: 19) observe that in STS research, a reflexive approach is "more talk than practice".

The concept of positionality indicates the situatedness of any researcher and enables the context of their research to be taken into account (Vilsmaier et al., 2017). Our approach to positionality is both epistemological and methodological. We understand positionality of a formative accompanying researcher to comprise three inter-related aspects. At a practical level (i) positionality describes *physical location*, the temporal and spatial proximity to the research team with which a formative accompanying researcher works, and their constantly shifting positions in relation to the team. These movements indicate that (ii) positionality also represents *methodological strategies* a formative accompanying researcher can adopt to navigate degrees of proximity. These strategies further imply that

(iii) positionality is a *reflexive research practice* of adjusting proximity, taking seriously the ethical considerations of power inherent in being both participant and observer (Eyben, 2009).

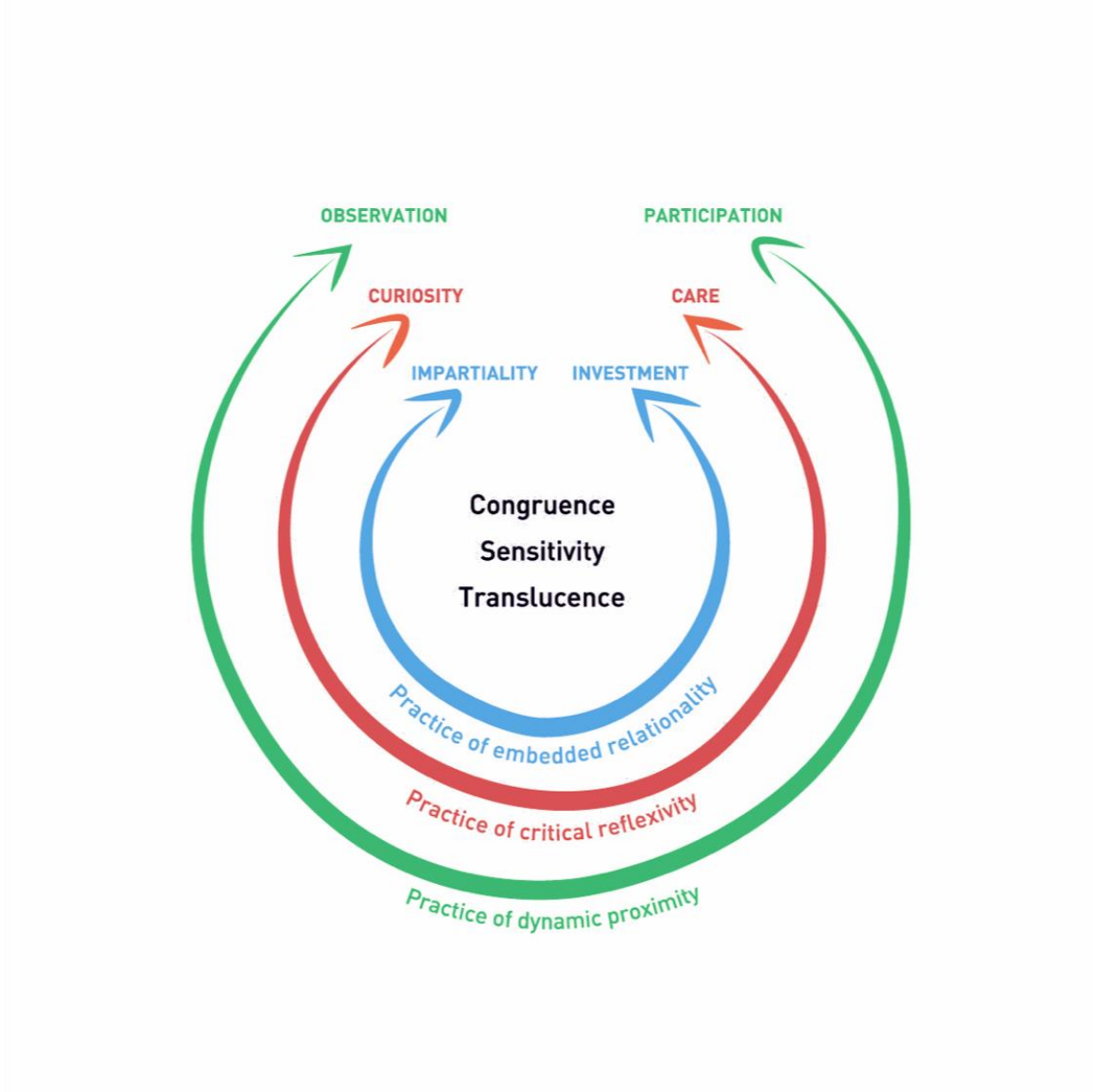

Figure 6: Navigating FAR positionality

Balancing acts, practices and principles.

Figure 6 presents three sets of tensions a formative accompanying researcher is likely to encounter that may pull them in multiple directions. We translate these tensions into three balancing acts for a researcher to navigate, guided by practices and principles. The first balancing act between **participation** and **observation** amplifies well-documented tensions inherent in conducting participant observation, (e.g. Pink 2012; Quinn Patton

2014). This is also expressed as being an "insider-outsider" (Humphrey, 2007) and has implications for *what the researcher can see* by virtue of their location in relation to the collaborating team. A second balancing act between **curiosity** and **care** relates to *how the researcher sees,* through the kind of "scientific gaze" they adopt (Haraway 1988). The third balancing act between i**mpartiality** and **investment** deals with the *visibility of the researcher's own interests,* related to dynamics of partiality and power in research relationships (e.g. Blædel 2013).

If one assumed that balance was something to be found and then maintained, it would be tempting to use these balancing acts as an answer to the question: should the FAR researcher be an impartial *or* invested observer *or* participant, acting with curiosity *or* care? Instead we propose that each balancing act represents a continuum and that all positions along this continuum are possible and appropriate at different times. Moreover, no position exists independently but in relation to other positions on the continuum. Each continuum is curved to express the idea that the ends are not polar opposites (Figure 6). This opens up the possibility that moving from one end of a continuum to the other could happen by traversing the full line between them, or by leaping the gap. Presented this way, the balancing acts are designed as an instrument to identify, at a particular moment in time, the particular co-ordinates of the researcher's positionality, and movement between different moments in time. This helps to inform a reflexive FAR practice without inhibiting its characteristic fluidity.

4.1 Balancing Act 1: Observation and participation

Bruno Latour (1999: 26), accustomed to tracking scientists and their science in laboratories and archives, "decided for a change to observe a field expedition", accompanying a team of natural scientists to Brazil to take soil samples. As the others busied themselves with the technical rigors of their science, he turned his observing lens on himself, "What about me, standing here, useless, arms dangling …?" (1999: 47). When does a researcher, primed to do participant observation, instead find himself an awkward, gawking spectator?

This question about the degree to which a researcher is, at any time, more a participant or more an observer is a function of two interdependent aspects: their *location* nearer or further away, and their *role* as insider or outsider - or more accurately, as both insider and outsider. In terms of location, different degrees of proximity afford different perspectives (Berger, 2013), which holds "not only in a spatial but also in … metaphoric sense." (Breuer and Roth, 2003: 3). A researcher's proximity, whether literal or figurative, creates blind spots. One type of researcher blind spot is born of over-familiarity; a hazard

of being too close or "too much of an insider" (Gunasekara, 2007: 469). Another risk of close proximity, but the opposite of a blind spot, is magnification. If a researcher is highly sensitized to a particular phenomenon, they might exaggerate its presence in their observations (Russell and Kelly, 2002). Science has been studied across a spectrum of proximities, from far away in space and time (e.g. Kuhn's 1963 reconstruction of Newton's scientific revolution) to very close in space and time (e.g. Knorr Cetina's 1999 ethnographic work in laboratories). However, Knorr Cetina was an outsider to the scientific team, pursuing her own research questions. Hackett and Rhoten (2011) differentiate between inside-out and outside-in STS. FAR represents a case of the former, pursuing research questions developed in consultation with the collaborative interdisciplinary team being researched.

Inside-out research has consequences for how the researcher's role is perceived, often resulting in multiple, conflicting expectations (Brohm, 2009). The ones being researched may harbour and express concern about this role, not least because of the legacy of the science wars, which continue to cast a shadow (Fortun, 2005). Humphrey (2007: 23) warns that an insider-outsider "can be pushed and pulled along an invisible insider-outsider continuum by others who have a vested interest in who she is and what she is doing …"

We propose a practice of dynamic proximity to manage the inherent paradoxes of this balancing act between observation and participation. Inspired by the dialectical approach of Eberle & Maeder (2011) to organizational ethnography, a FAR practice of dynamic proximity guides movement between:

- Being near enough to pick up details, and far away enough to be able to see as much of the whole-in-context as possible;
- Being near enough to discern opportunities for team reflection, but not so close that this happens solely by virtue of the formative accompanying researcher's intervention; and
- Being near enough to perceive when the conditions are ripe for team-level learning, and to nurture these conditions, and far away enough to avoid imposing a learning agenda.

Studying a team from multiple perspectives along the observation – participation continuum can render internal enablers and disablers of interdisciplinary and interpersonal collaboration more visible. Given that such dynamics are "rarely recognised let alone discussed" in academia (Strober, 2011: 2), it becomes important how the researcher balances curiosity and care in the scientific gaze they direct towards the collaborative team.

4.2 Balancing Act 2: Curiosity and care

Curious researchers can set in motion a series of unintended consequences for the situation they are studying. If even the seemingly benign act of interviewing can trigger changes in interviewees' relationships with what they had previously taken for granted (Müller and Kenney, 2014), does the researcher have a responsibility to take greater care?

STS research has at times been characterised by a particularly intrusive brand of curiosity, epitomizing "powerful rhetorics of witnessing and revelation" (Garforth, 2012). The question of care has gained significant attention in recent years with moves from a dispassionate stance to recognition that "[I]f something is constructed, then it means it is fragile and thus in need of great care and caution" (Latour, 2004: 247). Puig de la Bellacasa builds on this, suggesting that where other people are involved, "care is a doing necessary for significant relating" (2011: 98). Conscious that care taken by women researchers could fall into gender stereotyping traps, she asserts that it is possible to care in a non-sentimental fashion. In a similar vein, Atkinson-Graham et al. (2015: 746) refer to a "politics of care". Thus scientific curiosity, described by McCarty (2016: 79), as the "urge to know" is still given free rein, but is a more careful curiosity, attuned to possible impacts of the research on the other and the potential that "accompaniment" in science can "…contribute to and constitute a *flourishing* existence." (Rabinow, 2011: 217)

In the case of FAR, the notion of 'accompaniment' implies walking in step with those being researched. This implies that the researcher's gaze is not always directed straight at the collaborative team but is sometimes cast with interest in the same direction in which they are looking. We propose a practice informed by "critical reflexivity" (Haraway, 1991: 197) to balance scientific curiosity and care, avoiding the extremes of cavalier intrusion and paralyzing caution. If critical reflexivity infers "turning of the researcher lens back onto oneself to recognize and take responsibility for one's own situatedness within the research and the effect that it may have on the setting and the people being studied … " (Berger, 2013: 220), a FAR practice of critical reflexivity enables movement between:

- Being curious enough to stay in inquiry mode, alert to surprise;
- Being caring enough to know when is the right time to dig deeper into inquiry. Some developments in collaborative teams need time to mature before being scrutinized; and
- Being non-sentimental enough to care about a team's wellbeing without becoming custodian of it.

Insights gained from learning *about* a team's epistemic and social dynamics in this way can potentially be used to learn *with* a team, opening up possibilities to reflect together on how team interactions either facilitate or hinder achievement of their shared research goal. However, this also creates the risk that the formative accompanying researcher becomes overinvested in the team's research success, which ushers in the third and final balancing act of impartiality and investment.

4.3 Balancing Act 3: Impartiality and investment

Where once the scientist's invisibility and detachment were sources of trustworthiness, now Haraway (1996, 2004) and Jasanoff (2004) suggest that the scientist is trustworthy only when they no longer erase their presence from their scientific work and instead deal with the consequences of presence.

Wherever a researcher is positioned on the observer – participant and curiosity – care continuums at any one time, they have vested interests that carry power. Thus in our third balancing act, we propose impartiality at one end of the continuum, distinguishing 'impartiality' as being aware of interests but seeking to remain unbiased, from 'neutrality' as claiming to be interest-free and/or unaware of interests. At the other end of the continuum is investment. When a FAR researcher observes a project meeting in which decisions are being made which affect them as a member of the project team, they are invested. The continuum as a whole is about degrees of conscious interest by a researcher in what is at stake. Haraway (1988: 584–585) does not see a contradiction between being objective and partial, advocating for "… a practice of objectivity that privileges contestation, deconstruction, passionate construction, webbed connections, and hope for transformation of knowledge and ways of seeing." Whether learning about, with or for an interdisciplinary team, the researcher is in relationship with the people and situations she is researching. What, and who, she is studying matters to her.

To balance impartiality and investment, we propose a third practice of "embedded relationality", which considers partiality – which is not the opposite of impartiality – an inevitable consequence of being in relationship. Haraway's understanding of "embedded relationality" is that it produces "partial, locatable, critical knowledges sustaining the possibility of webs of connection called solidarity in politics and shared conversations in epistemology." (1991: 191). A practice of *embedded relationality* involves:

- Sometimes explicitly claiming the power granted by an insider-outsider perspective to interpret research material;
- At other times deferring to the interpretations of team members by virtue of their insider lived experience; and

- Most times, an engagement between researcher and team to enrich interpretation from both perspectives without resorting to lowest common denominator compromise.

If the positionality of a participant observer can never be interest-free, the alternative is to actively deal with the interests and power vested in their position. For this reason, we advocate identifying principles that can realize an ethics implicit to navigating positionality.

5 Anchoring principles

The three balancing acts and practices can serve as navigating instruments for a highly mobile approach to researcher positionality. However, this could still result in too many degrees of freedom. We therefore propose that researchers identify key principles that can act as anchors for their practice, securing a starting point and enabling movement within a certain circumference. The principles we found useful may not be as relevant to other researchers due to the singularity of each research situation.

We anchored our FAR practices in the following principles:

- Congruence: STS researchers have been criticised for repeating the epistemological or methodological 'mistakes' that they critique others for committing (Roth and Breuer, 2003). To be congruent in our FAR work, as it became increasingly focused on the difficulties of interdisciplinary collaboration, meant that our own research practice would have to pay particularly close attention to how we collaborated with others;
- Sensitivity: If we are studying projects and people in process, then "engaging with their becoming … affects the way we produce knowledge about things." (Puig de la Bellacasa, 2011: 100). According to Corbin & Strauss (2008: 41), sensitivity is derived from "immersion" in the research situation and hence being able to "…respond intellectually (and emotionally) to what is being said in the data…"..
- Translucence: Demands for greater transparency in research (Beaulieu 2010) represent a welcome (re)claiming of power by those who are researched, but transparency has become a cliché and thus lost the nuance of its meaning. There are also occasions that demand some degree of opacity, for example when early research findings are too embryonic to be shared productively. We are in favour of a FAR principle of translucence that allows light through while certain shapes remain indistinct. For example, in the process of drafting this article, we

presented our key ideas about FAR positionality to the Leverage Points research team for discussion and improvement.

The final part of this paper describes experiences of practicing FAR in the Leverage Points project. A series of three narratives, drawn from the research journal of the formative accompanying researcher, demonstrate how the balancing acts can work in practice for navigating positionality, providing some initial considerations for other STS researchers who aspire to advance collaborative research.

6 Producing situated knowledges: Three FAR narratives of navigation

The following narratives, presented in a chronological order, relate to experiences of moving between the three orientations of learning about, learning with and learning for a collaborative interdisciplinary team. Learning with and for a team opens up a messy world of possibilities, which the balancing acts can help to both anticipate and analyse. A particularly perplexing possibility appears where STS research and intervention meet (Zuiderent-Jerak and Jensen, 2007). The prospect of intervening can be both seductive and disorientating for an STS researcher (Hackett and Rhoten, 2011). Thus each FAR narrative provides a different window on our experiences of navigating positionality, when opportunities to intervene beckoned. The first narrative is an account of uninvited intervention. It demonstrates how the balancing acts (Figure 7) can be used as a heuristic instrument to track one's own navigation of positionality. The second and third narratives demonstrate more and less successful examples of navigating positionality, respectively, leading to reflections on the approach we have proposed in this article and what this implies for future research.

6.1 A situation of uninvited intervention

Six months into the FAR research, the formative accompanying researcher was observing a project management meeting. The nub of the discussion was about how to manage the consequences of making decisions, under resource constraints, that could trigger dynamics of inclusion and exclusion in the collaboration. Those present expressed acute concern about the impact on levels of happiness and trust in the team, while feeling pressure to take decisions. The discussion was open and those involved seemed unguarded and constructive in their exploration, but the meeting ended awkwardly, with an air of incompletion.

Cognisant that the dilemma had not been satisfactorily addressed and that the stakes were high, the formative accompanying researcher leaned forward from her position outside the circle of chairs and asked if she could speak “in the spirit of not only being an observer but also having a reflection role.” After getting a clear yes, she did three things: First, she provided a perspective garnered from one-to-one interviews with team members (including all the people at the meeting), which had revealed a perceived ethos of goodwill and trust in the project, and which had been experienced as fostering creativity and productivity in the early stages of the collaboration. Second she posed a question to reframe the dilemma by saying: “If you knew that this ethos was a resource in the project, how could you handle this situation in a way that both assumes its availability, and continues to build it?” Third, she offered the opinion, that “each of us in the project is responsible for our own happiness.”

This narrative demonstrates a FAR practice of dynamic proximity, with movement from one research position to another in response to considerations of care and investment. The primary move was from a position of learning *about* the team to learning *for* them, in support of the team. Prompted by a practice of *critical reflexivity*, it combined the roles of researcher-as-observer and researcher-as-participant by providing information gleaned from an exercise in *curiosity* (interviews) that only she had access to. And while it risked compromising perceptions of her as *impartial*, it prioritised the principle of *translucence* in the face of an ethical concern (wellbeing and trust in the team). In this way, the formative accompanying researcher’s intervention represented *sensitivity* to a critical juncture of the project. Where these movements lost balance and over-stepped the principle of *embedded relationality* was in expressing a personal opinion about happiness, which referred to ‘us’ from her perspective, rather than perspectives gathered from her research.

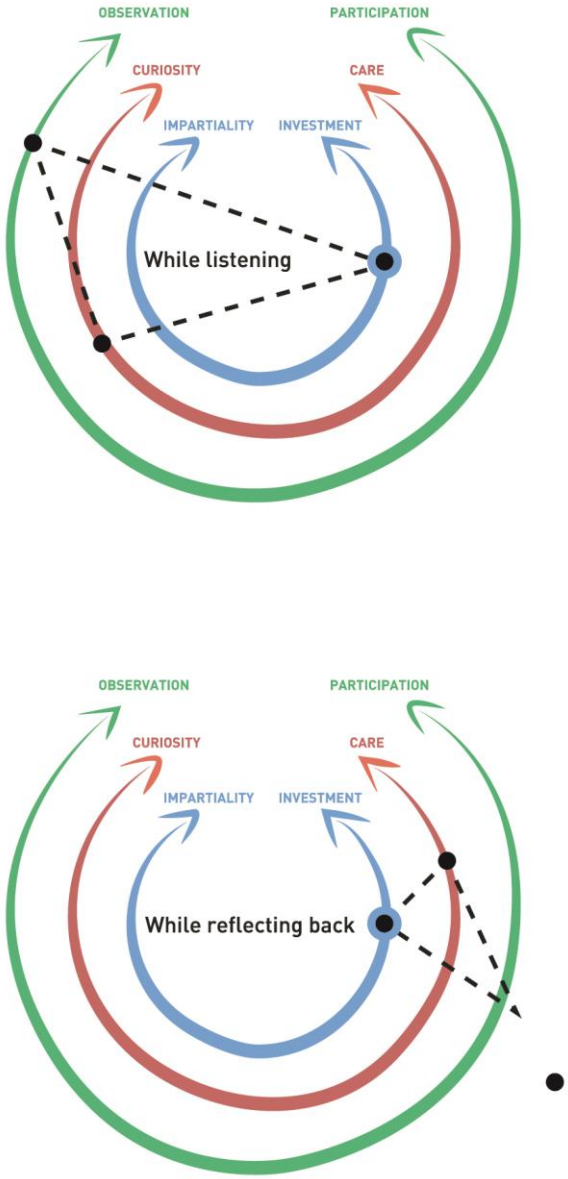

Figure 7: The balancing acts as a heuristic.

Tracking dynamic FAR positionality while conducting participant observation. The top figure presents co-ordinates of the researcher's positionality while learning about. The bottom figure demonstrates how this changed when the researcher moved to learning for.

6.2 A situation of co-created intervention

Mid-way through the Leverage Points project, the team was in a transition phase from open and divergent explorations of its research question to needing to demonstrate progress and move towards convergent outcomes. Inevitably, this transition was creating some disruption, and team morale dipped. A team meeting came to a somewhat disgruntled close, making these dynamics more evident than they had been before, but remaining un-named. As her colleagues started to move towards the door, the formative accompanying researcher who was attending as a participant observer opened her mouth to name these dynamics and then closed it again. The timing was wrong to make an unsolicited observation.

Minutes later, a senior member of the team knocked on her office door. He was worried about the prevailing “heavy atmosphere”; was it possible to do something about it? After discussing the situation and some options to address it, the formative accompanying researcher approached one of the project managers to share with him insights arising from that discussion. Initially, he didn’t agree that it was a team-wide issue, but rather a manifestation of academic stresses on individual members. The formative accompanying researcher countered his analysis, drawing on material from recent observations and interviews, which indicated that the project as a whole was grappling with the transition phase. The manager responded fast, immediately issuing an invitation to the team to attend an informal meeting to discuss reasons for low morale and how to address them. The ensuing meeting, co-facilitated by the manager and formative accompanying researcher, seemed to act as a pressure relief valve while also distributing responsibility for addressing sources of frustration among different members of the team.

In this situation, the formative accompanying researcher decided not to act on her concerns about morale until initiative had come from within the team itself. Because she had come to *care* about the team’s wellbeing and was *invested* in the team navigating this transition well, she interpreted the knock on her door as a nudge to intervene (i.e., to learn *for*) rather than as merely interesting information (i.e., learning *about*). However, she had to rein in a desire to ‘rescue’ the situation single-handedly. It proved much more effective to work alongside the manager to create a team experience of collectively making sense of the situation and reaching decisions about what was needed (i.e., learning *with*). The meeting itself was a further source of FAR data and so *curiosity and care* could continue to co-exist. In a concrete instance of being *translucent* but not transparent, the formative accompanying researcher produced two versions of the notes she took during the meeting; one for her own field notes and a less detailed record for the team, later distributed by the manager.

This co-created intervention demonstrated, in a very modest way, the potential to combine learning about, with and for a team, in the interests of advancing collaboration. It was one of several small initiatives that helped the team to move into the next phase of integration.

6.3 A situation of invited intervention

A few months later, the formative accompanying researcher was invited to join the integration team while one of the principal investigators was on maternity leave. She accepted with alacrity; her curiosity to learn about the team was starting to run dry and it was a relief to be asked to expand her role by actively contributing to project outcomes, learning for the team in its integration efforts.

However, taking on this new role restricted the formative accompanying researcher's fluidity of movement between different learning orientations. The integration role had hooked her in several ways; it called on her process facilitation expertise, activated her interest in the content of the collaboration's research, and triggered a sense of responsibility for ensuring successful project outcomes. She found it increasingly difficult to discern when to *observe* what was happening and when to intervene and attempt to address what was happening. It became clear to her that she was too close to the team and too static in her positionality, and that this was inhibiting her effectiveness in all three learning orientations. On several occasions, she felt that her sense of *care* for the team was crowding out her *curiosity* about the team. This experience suggests that learning *for* a team should be approached with caution.

Reflecting on these experiences, we see the following early indications of advantages and limitations of navigating positionality in the way we have proposed. We found the three orientations to learning – about, with and for – to be a powerful combination. Together, these orientations produced information *about* the collaboration, which fed into collective (although not necessarily consensus-based) understanding and insight *with* the team, which served as a resource *for* the collaborative work, enabling the team to learn and adapt *in situ*. Moreover, the proposed balancing acts served as a useful heuristic device to monitor and navigate positionality at any given moment, and over time. A collaborative research project constantly evolves through different phases, and the FAR role has to adapt alongside these changes. The practice of embedded relationality helped to track what was happening, both in the team and between the formative accompanying researcher and the team. The practice of critical reflexivity enabled seeing what this implied for FAR positionality, and the practice of dynamic proximity guided next movements in response. The temptation to intervene was very strong. We learned,

through trial and error, the value of maintaining tension between the three learning orientations instead of overbalancing into intervention.

7 Conclusion: FAR's prospective contribution to interdisciplinary collaboration

This article took as its starting point that there is a growing demand for and interest in interdisciplinary research, but that this kind of work is difficult and there remains a lack of empirical study to bolster its practice. Such a situation can be described as constituting risk for interdisciplinary collaboration. As stated by Callard et al (2015: 6) ,"Interdisciplinarity is necessarily and irrevocably a practice that entwines bodies, minds, geographies and temporalities in creative, ambivalent and often conflictual ways. The point of tracking the signal and tracing the noise of its explicit and not-so-explicit contours is precisely to do justice to these dynamics." The question of how to do justice to these dynamics is key.

Can an STS researcher, such as one conducting FAR, also advance collaboration? While we see small positive indications of this, for instance in the second narrative of co-created intervention, we also see the pitfalls and cannot yet claim that this approach has significantly advanced collaborative interdisciplinary research in the Leverage Points project. The next phase of our research will focus here, approaching these experiences systematically with an ex-post analysis as the project draws to a close. What we do claim is that we have learned something useful about how to navigate positionality by adopting a particular presence and set of practices, guided by a "no-nonsense" (Haraway, 1991: 197) brand of congruence, sensitivity and translucence. This, we argue, will contribute to an STS research practice that can fruitfully "track the signal and trace the noise" of interdisciplinary collaborations amid a cacophony of signals, noises, distractions and demands.

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CHAPTER 3

LEARNING TO COLLABORATE WHILE COLLABORATING: ADVANCING INTERDISCIPLINARY SUSTAINABILITY RESEARCH

Rebecca Freeth and Guido Caniglia

ABSTRACT

Interdisciplinary collaboration has become mainstream practice for sustainability researchers. However, the literature increasingly highlights that such collaborations often encounter numerous challenges and we still lack clear concepts and strategies to address them. In this article, we make a conceptual proposal for learning to collaborate while collaborating, so as to tackle challenges of interdisciplinary research for sustainability. Combining Felt's idea of epistemic living spaces with the idea that discomfort induced by challenges can be used as a prompt for learning, we suggest thinking about collaborations as spaces that (i) comprise epistemic, social, symbolic, spatial, and temporal dimensions and (ii) produce different degrees of comfort and discomfort for researchers, which has implications for intentionally generating learning. We argue that we can advance collaborative interdisciplinary research for sustainability by creating and engaging in collaborations in ways that prioritize learning to collaborate. We outline a strategy for learning to collaborate while collaborating, which implies: (i) creating conditions for learning to take place, which includes paying attention to levels of discomfort inside the collaboration as triggers for learning and (ii) engaging in collaborations in ways that strengthen researchers' collaborative capacities by cultivating particular orientations, knowledge and skills. The fundamental inquiry is whether and how learning to collaborate has a role in more fully realizing the inspiring potentials and ambitious goals of interdisciplinary research for sustainability.

1 Introduction

Sustainability research aims to generate knowledge that can help address wicked social-ecological problems of our time, from loss of biodiversity to the consequences of climate change (Clark et al., 2016). It is clear that this kind of knowledge is best generated by engaging with and integrating multiple perspectives (Miller, 2013; van Breda and Swilling, 2018; van Kerkhoff, 2014). Within academia, this has created an imperative to engage in interdisciplinary collaboration, which mobilizes theories, methods, and practices from the natural, social, and human sciences (Holm et al., 2013; Jerneck et al., 2011). And yet, the collaborative dimension of interdisciplinary research is often not adequately taken into account when initiating and engaging in interdisciplinary research (Defila and Di Giulio, 2017; Lyall, Bruce, Tait, et al., 2011). In this paper, we argue that, if we want to advance sustainability research in achieving its goals, it is important to take the collaborative dimension of interdisciplinary research seriously (Bettencourt and Kaur, 2011; Fazey et al., 2018). This includes recognizing that researchers entering collaborations do not automatically possess the necessary collaborative skills (Cheruvelil et al., 2014) and thus implies creating conditions for teams and individual researchers to learn to collaborate with others.

In the field of sustainability at large, there is growing appreciation of the need to actively support learning processes that enable people to work well together. In higher education for sustainability, for example, this is evident in the design of new sustainability curricula and programs that position learning to collaborate as a key objective of sustainability education (Caniglia et al., 2018; Wiek et al., 2011). Acknowledgement of the importance of learning to collaborate has also gained momentum in multi-stakeholder transdisciplinary collaborations, through such approaches as embedded case-studies (e.g., Scholz and Tietje, 2002), case-based mutual learning (e.g., Vilsmaier et al., 2015), and reflexive monitoring (van Mierlo et al., 2010). However, these developments in higher education and transdisciplinary research for sustainability are not yet matched in interdisciplinary research collaborations (following Bammer, 2017). Here, there appears to be an assumption that both senior and junior researchers recruited to interdisciplinary projects are already equipped with the full range of capacities needed to be able to collaborate across disciplinary differences.

Yet there is evidence that projects designed for “integrative interdisciplinarity” are often reduced to “additive multidisciplinarity” (Roy et al., 2013: 745) at least in part due to failure to navigate challenges of collaboration. Such challenges range from difficulties of finding conceptual common ground to difficulties of managing interpersonal tensions (Haider et al., 2017; Klein, 1996; Strober, 2011). It is also increasingly clear that, even if

researchers have had previous interdisciplinary education or experience, collaboration is "unabatedly demanding" (Defila and Di Giulio, 2018: 101) and a new project can present novel and unexpected challenges, even for experienced researchers. These considerations, we suggest, should invite those in charge of and involved in interdisciplinary collaborations to abandon the assumption that sustainability researchers know how to collaborate in interdisciplinary settings. Abandoning this assumption requires identifying ways in which interdisciplinary teams and individual researchers in teams can learn how to work together across differences and has implications for how to think about, design, and engage in collaborative interdisciplinary projects.

The approach of this paper combines a literature review of challenges of collaborative research with illustrative material derived from empirical exploration of a collaborative interdisciplinary research project in the field of sustainability. The project in question, Leverage Points for Sustainability Transformation (https://leveragepoints.org), was inspired by the work of Donella Meadows (2008) to critically examine deep leverage points for addressing root causes of unsustainability (Abson et al., 2016). Empirical material included in this article was gathered by the first author [Freeth] in the role of a formative accompanying researcher responsible for tracking the team's collaborative experiences over the full duration of the project (Freeth & Vilsmaier, in review). Both the literature review and empirical exploration revealed multiple challenges of interdisciplinary collaboration. However, these challenges are not usually comprehensively and systematically organized in the literature, which makes it difficult for researchers to know how to address them. Thus, we present a conceptual model that allows for the comprehensive and systematic organization of challenges and propose an overarching learning strategy to address them. In suggesting this strategy, the paper does not try to provide a methodological toolkit, nor does it present a solution that would work in any kind of collaboration. Rather, it offers a way to think about, design, and engage in interdisciplinary research, which has at its core the recognition that researchers need to learn to collaborate more effectively with one another.

Section 2 proposes a conceptual model for thinking about interdisciplinary research collaborations as (a) encompassing epistemic, social, symbolic, spatial, and temporal dimensions and (b) involving varying degrees of comfort and discomfort. Using this model, Section 3 organizes challenges of interdisciplinary research from the literature. Section 4 presents the main features of our learning strategy. We illustrate each of these sections with examples drawn from the Leverage Points collaboration. Section 5 concludes by indicating possibilities for taking this learning strategy forward.

2 Rethinking collaborative interdisciplinary research

We start from the following widely accepted definition of interdisciplinary research as: "... a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice." (NAS, 2005: 26). This definition highlights two features of interdisciplinary research in general and of interdisciplinary research for sustainability, in particular. First, it makes clear that interdisciplinary research can be conducted in teams or by individual researchers. We focus on interdisciplinary research as it takes place in teams given the expectation that sustainability research should involve a high degree of interdependence between researchers from different disciplines and fields (Balvanera et al., 2015). Second, the definition points out that interdisciplinary research can serve both to better understand complex problems and to find solutions to those problems. This characteristic explains why interdisciplinarity is a hallmark of both problem and action-oriented sustainability research (Bammer, 2017; Rau et al., 2018).

However, similar to other definitions of interdisciplinarity (e.g., Huutoniemi et al., 2010) the definition above focuses primarily on epistemic and cognitive dimensions of interdisciplinary work (e.g. information, data, technique, concepts, disciplines). Yet, in the process of conducting interdisciplinary work, researchers bring in not only the epistemic characteristics of their disciplinary background, but also many other aspects of their professional and personal life (Callard et al., 2015). As emphasized by Boix-Mansilla et al. (2016: 32), the language of interdisciplinarity often "[...] foregrounds an encounter between disciplines and masks the many other aspects of similarity and difference that constitute collaborative experiences". This is especially relevant in the field of sustainability. Here, due to the contentious and normative nature of wicked sustainability problems, exchanges among researchers also involve their beliefs and worldviews, normative and political orientations, embodied life experiences, and personal dispositions (Ives, Freeth & Fischer, in review). These multiple elements of difference can create situations of discomfort, which can hamper the potential of an interdisciplinary team to thrive or can be used to support learning to collaborate and allow for the team to reach its full potential.

The Leverage Points project can help illustrate the multiple dimensions of difference that characterize an interdisciplinary collaboration in the field of sustainability. The project team comprised 23 researchers from multiple disciplinary fields including the environmental sciences, ecology, geography, political science and international

development. There were also members with a background in social work, environmental law, mechanical engineering and product design. Most researchers described themselves as disciplinary boundary crossers, rather than fitting neatly within any one field. Originally from eight different countries, they were co-located at Leuphana University in the German city of Lüneburg for the duration of the project. Most researchers were white, middle class, raised in a Western culture, and ranged in age from mid twenties to mid forties at project onset. Despite this apparent homogeneity, there were strongly divergent approaches to leadership and views on how best to collaborate, expressed for example in different ways of taking and following individual initiative. All of these multiple sources of similarity and difference had an effect on the team's experiences of collaborating.

In the remainder of this section, we explore two approaches that make it possible to rethink interdisciplinary collaborations as spaces that combine multiple sources of similarity and difference, and which can give rise to different levels of comfort and discomfort. First, we use Felt's (2009) idea of *epistemic living spaces*, which helps to conceptualize collaborative interdisciplinary research as more than an epistemic endeavor. Second, we make use of experiential and relational theories of learning (e.g. Kolb 1984; Mezirow 2009) to think about interdisciplinary research collaborations as spaces in which researchers experience different degrees of comfort and discomfort, which, if appropriately addressed, can be conducive to learning to collaborate.

2.1 Thinking about collaborative interdisciplinary research as multidimensional

Ulrike Felt (2009) coined the concept of *epistemic living spaces* to describe multi-faceted interactions between researchers and their working environments, including the "structures, contexts, rationales, actors, and values which mould, guide and delimit their potential actions" and what researchers do to "...stabilise, extend and protect the space they occupy…" (Felt and Fochler, 2012). She and her colleagues have applied this concept to their study of several large research projects in Europe to investigate mono-disciplinary and cross-disciplinary research experiences (e.g., Felt, 2009, 2010, 2017). Over this time, they have identified multiple dimensions that constitute an epistemic living space. Five dimensions they have consistently applied are: epistemic, social, symbolic, spatial and temporal (e.g. Felt et al., 2012).

While Felt (2009: 19) indicates that the epistemic living space concept helps to describe both "individual and collectively shared" experiences in research, the collective perspective remains under-explored in her work. We adopt the concept of *collaborative*

epistemic living spaces to better understand the epistemic, social, symbolic, spatial, and temporal dimensions involved in collaborative interdisciplinary research for sustainability, describe their challenges and develop strategies to learn to more effectively navigate such collaborations. Separation into five different dimensions serves descriptive and analytic purposes, but in reality the dimensions are "inextricably intertwined" (Felt and Fochler, 2012). While acknowledging their interconnectedness, in the rest of this article we keep the different dimensions separate in order to identify and organize challenges of collaboration from the literature as well as to propose a strategy that can help overcome challenges in practice. We describe the five dimensions of a collaborative epistemic living space in sustainability as follows:

- The *epistemic* dimension focuses on different assumptions about which research questions are central, how knowledge should be produced and which properties and procedures constitute good knowledge (Felt and Fochler, 2012). In the field of sustainability research, interdisciplinary teams are tasked with creating knowledge that is salient, credible and legitimate (Cash et al., 2003), while accepting that uncertainty and lack of consensus will always be a feature of their work (Miller, 2013);
- The *social* dimension highlights the range of ways of being together in research and relations with both peers and competitors in collaborative knowledge production (Felt et al., 2012). Included in the social dimension are the emotional dynamics of interdisciplinary collaboration (Boix Mansilla et al., 2016; Griffin et al., 2013), which encompass interpersonal experiences of psychological safety and trust (Edmondson, 1999; Parker and Hackett, 2012) . Given the focus of sustainability research on future wellbeing, teams of sustainability researchers may be particularly emotionally invested in their work (Hoggett and Randall, 2016);
- The *symbolic* dimension pays attention to competing values and top-down modes of ordering in governing and organizing research, and the resulting expectations that trickle down to researchers, such as contemporary expectations of research excellence or accountability (Felt et al., 2012). In sustainability research, power differentials are of particular relevance (Vilsmaier et al., 2017; Wals and Corcoran, 2012). There is also growing acknowledgement that sustainability researchers, perhaps more so than in most fields, tend to hold strong, and sometimes conflicting, normative assumptions. For example, about what constitutes a sustainable future (Schmieg et al., 2017);
- The *spatial* dimension encompasses literal ways in which different spaces enable or constrain collective research work, as well as a metaphorical sense of belonging within different research communities (Felt and Fochler, 2012; Gieryn,

2000; Star and Griesemer, 1989). While much sustainability research is local and place-based, research teams themselves are often international, representing a diversity of experiences shaped by nationality, ethnicity and global geo-politics (Balvanera et al., 2015); and

- The *temporal* dimension deals with different tempos, time regimes and forms of time in interdisciplinary research, particularly when different times frames – of projects, contracts and careers – are involved (Felt et al., 2012). Different disciplines conduct research at different paces (Felt, 2009). In sustainability research, there is the added pressure of a sense of urgency in relation to the wellbeing of social-ecological systems (van der Leeuw et al., 2012).

The Leverage Points project offers an example of how the different dimensions of an interdisciplinary research project contribute to the creation of a collaborative epistemic living space. The research agenda of the Leverage Points project addressed three realms of leverage for sustainability: rethinking knowledge, restructuring institutions and reconnecting people and nature (Abson et al., 2016). This agenda was translated into an organizational structure of three research work packages, enabling researchers with different disciplinary backgrounds but similar *epistemic* interests to cluster around particular lines of inquiry in pursuit of the overall research question. Each work package established its own *temporal* rhythm and pace of work. The principal investigators gave considerable thought to promoting positive *social* engagement between researchers. This included locating the project in a building that met the *spatial* requirement of accommodating the team in shared offices within a single corridor, and having use of a social room for both formal and informal gatherings. While the project structure reflected a conventional hierarchy from principal investigators down to post-doctoral and doctoral researchers, the project culture *symbolically* promoted a high degree of inclusivity and equality through its modes of daily interaction.

2.2 Thinking about collaborative interdisciplinary research as uncomfortable

Ideally, research collaborations are environments in which researchers feel “intellectually and socially at home” and as being on “safe ground from which unknown territories may be explored and claims made.” (Felt et al., 2009: 19). In reality, diversity and disagreement in interdisciplinary engagement can create distinct discomfort (Strober, 2011). Horst (2013: 39) argues that in collaboration, “…a sense of discomfort often works as an alarm signal that calls for further investigation.” Investigating discomfort implies looking at challenging experiences and relationships that animate the multidimensional space of a research collaboration. This framing accords with experiential learning

theories, which suggest that discomfort, if appropriately managed, can catalyze processes of re-examining difficult experiences in ways that promote learning (Kolb, 1984; Mezirow, 2009). Alternatively, if experiences of discomfort are not addressed, they can undermine the effective and satisfying collaborative experience of a team.

Tom Senninger's *learning zone model* (2000; Holthoff and Harbo, 2011) provides a starting point to think about interdisciplinary research collaborations as experiential and relational spaces characterized by different degrees of comfort or discomfort. Senninger identifies three zones, ranging from a high level of comfort to a high level of discomfort. He refers to these as a comfort zone, a learning zone, and a panic zone, which we simply refer to as a discomfort zone.

If applied to the case of an interdisciplinary collaboration, the comfort zone corresponds to experiences that are safe and familiar. In this instance, researchers experience satisfying progress, good relationships and general wellbeing. However, this zone is also characterized by predictability and there may be little incentive to challenge one's own assumptions or explore new ways to find answers to complex questions facing sustainability research. At the other extreme, high levels of collaborative novelty, dissonance or conflict can engender deep discomfort. Researchers experiencing high levels of discomfort may feel cognitively or emotionally overwhelmed, which can block open inquiry, reflection on sources of discomfort and creative collaborative thinking to address complex research questions (Tauritz, 2012).

Different individuals have different levels of tolerance to discomfort, indicating that members of a team may be operating in different zones during the same collaborative experience. How individual researchers experience comfort and discomfort can affect how the team as a whole engages with challenges (Brown and Lambert, 2013 following Kolb, 1984). For instance, in the Leverage Points team, one member found that the prevailing approach to collaboration was "…to not upset others" and appreciated this, while another experienced this as "too harmonious", lacking the necessary friction to deal with, and learn from, issues impeding collaboration. Thus, if a member of a collaborative team sees conflict as positive while most of their colleagues are averse to conflict, that person's way of engaging in disagreements may create a degree of discomfort that their colleagues find hard to tolerate. Similar situations, if not actively addressed, can limit the potential of an interdisciplinary team to fully unfold.

Between the zones of comfort and high discomfort, it is possible to create a learning zone. Some discomfort can provide fertile ground for learning, as long as it does not exceed coping thresholds (do Mar Pereira, 2012). Therefore, the learning zone is characterized by a manageable degree of discomfort, which can be used to motivate

researchers to engage with the challenges they are facing. As with the comfort and discomfort zones, the learning zone is both experiential (Kolb, 1984) and relational (Baker et al., 2002). Learning to collaborate emerges from processes that draw on researchers' direct experiences (experiential) of working together (relational). This implies that uncomfortable challenges – epistemic, social, symbolic, spatial and/or temporal – can create prospects for learning how to effectively collaborate with others while collaborating. The experiential and relational quality of learning emphasizes that researchers cannot learn to collaborate by reading about collaboration theories from books or teamwork manuals alone. On the contrary, researchers learn to collaborate across plural differences when they are actively engaged in collaborating, aware of challenging experiences and able to reflect on them in order to make changes to how they collaborate (Kolb, 1984). This can enable researchers to learn to collaborate while collaborating.

An example from the Leverage Points project provides a concrete illustration of how we are proposing to think about collaborative interdisciplinary research as multidimensional spaces between comfort and discomfort where learning to collaborate can take place, if intentionally fostered. Every year, the team held a retreat to take stock of the project and to plan ahead. The retreat situation allowed the formative accompanying researcher to observe interpersonal dynamics characterizing the multidimensional space of the research team and to track patterns of movement between comfort and discomfort. The principal investigators, most of whom had known each other for several years, set a tone of relative ease when disagreements were of an epistemic nature. On occasion, when disagreements were about different ways of being together (social dimension), or about differentials of power and authority (symbolic dimension), the temperature of the discussion would rise. Some viewed the heat of these exchanges positively and found that it enabled misunderstandings to be expressed and addressed. But for a critical mass of individuals in the team, these disagreements created a high degree of discomfort, which precipitated a collective tendency to return to the comfort zone, for instance by not engaging with conversations and interactions across disciplines, but rather going back to the more comfortable work of a single discipline. At the time, this appeared to bypass opportunities to inquire into sources of discomfort so as to learn together. However, after each retreat, once levels of discomfort had subsided, there would be considerable reflection on these experiences by individuals and in small group configurations. Discomfort thus was turned into a source of experiential and relational learning through active reflections and discussions.

2.3 Interdisciplinary research collaborations as multidimensional spaces between comfort and discomfort

In summary, we propose thinking about interdisciplinary research collaborations in sustainability as bringing together Felt's idea of multidimensional epistemic living spaces with the idea that discomfort can be used to prompt learning to collaborate. Figure 8 provides a visualization of our proposal. This visualization suggests that discomfort may arise in any, or a combination, of the epistemic, social, symbolic, spatial and temporal dimensions. Furthermore, it emphasizes the importance of intentionally creating a learning zone in each dimension. Stars represent the location of different individuals in different zones and dimensions of an epistemic living space in response to a collective experience. In Figure 8, it is possible to see that a single challenging experience could have different dimensional implications for different researchers (in this example, epistemic, symbolic and temporal) and trigger different levels of comfort and discomfort in each of the researchers.

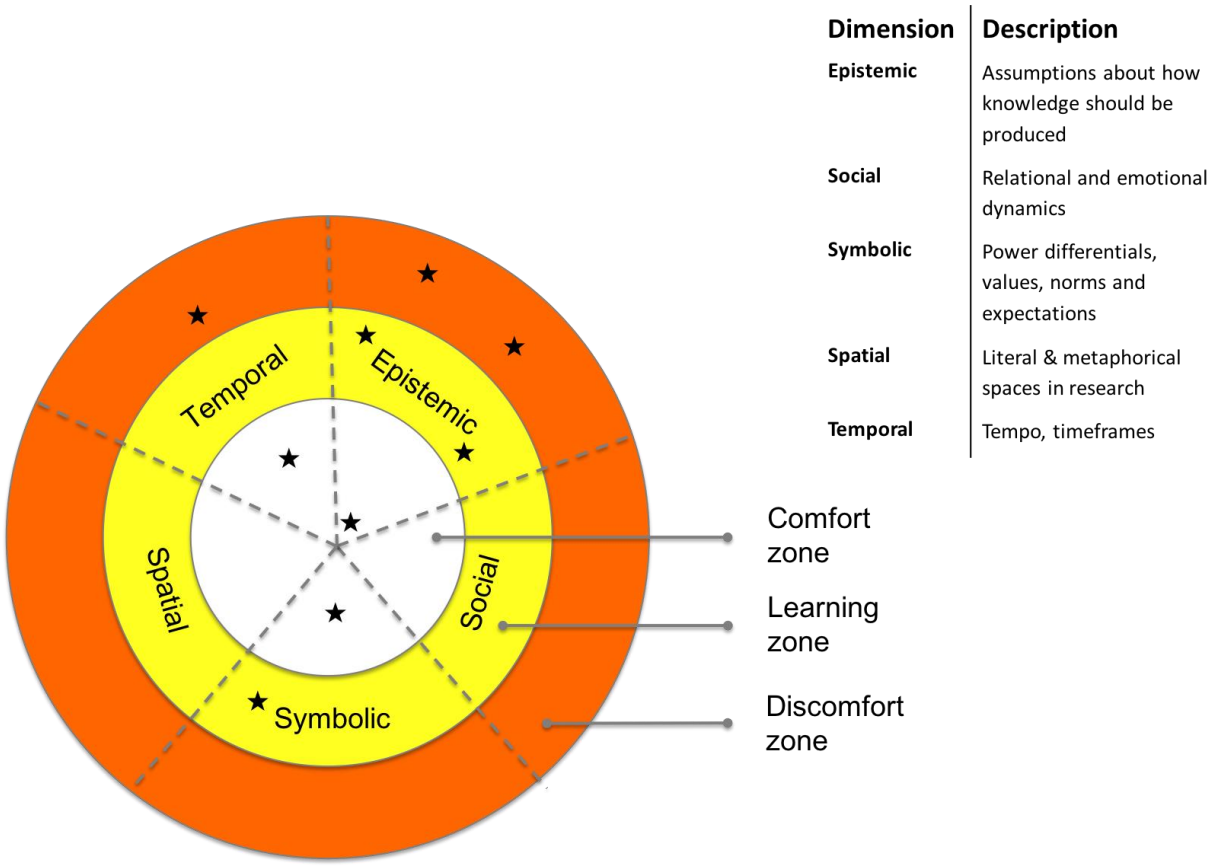

Figure 8: Comfort, discomfort and learning zones

organized according to the five dimensions of a collaborative epistemic living space and demonstrating that individual members of a team occupy and move between different zones in the five dimensions at different times

3 Challenges of interdisciplinary research collaborations

Thinking about collaborative experiences in terms of discomfort levels leads to examining the kinds of challenges that can provoke discomfort in interdisciplinary teams. When challenges override the benefits of collaborative research, their cumulative effects can fundamentally compromise the viability of an interdisciplinary collaboration (Lyall, Bruce, Tait, et al., 2011). Filtering such challenges through the five dimensions of a collaborative epistemic living space provides a systematic way of taking challenges into account. It also creates possibilities to address challenges more systematically, in order to realize the benefits of a collaborative epistemic living space, such as rewarding relationships, stimulating intellectual exchange and a sense of belonging.

Table 8 presents a compilation of challenges identified in the literature on collaborative interdisciplinary research, organized according to the five dimensions of a collaborative epistemic living space. Working from the characteristic features of the epistemic, social, symbolic, spatial and temporal dimensions described in section 2.1, this table indicates the considerable difficulties that can develop when a diverse group of researchers work together. The challenges arise from different assumptions about knowledge production (epistemic) and different ways of being together (social), to power differentials and how these can shape values, norms and expectations in a team (symbolic), use of collaborative spatial arrangements (spatial), and different perceptions of time in interdisciplinary research (temporal). We illustrate the different kinds of challenges that emerged from the literature with quotes gathered from members of the Leverage Points project when reflecting on the more challenging aspects of collaborating.

CELS dimension and characteristics	Collaboration challenges in literature	Examples from a collaborative interdisciplinary project
Epistemic: **Different assumptions about which research questions are central, how knowledge should be produced and what constitutes good knowledge**	Difficulties of finding common ground between heterogeneous research agendas, disciplines, conceptual definitions, methods, tools and research products (Eigenbrode et al., 2007; Lyall, Bruce, Tait, et al., 2011); This lack of common ground can exacerbate complexity, uncertainty, and conceptual ambiguity (Cheruvelil et al., 2014; Cilliers, 2001; Cosley et al., 2014); Lack of skill in synthesizing and integrating knowledge (Boix Mansilla, 2006).	"We have different notions of interdisciplinarity within the team, based on our different academic pathways. We expected there would be more common ground..." "At the beginning, I thought it was interesting that people had different viewpoints and backgrounds. Now … we're having to decide which ones are going to be larger driving forces in our work." "The process of integration is almost impossible to think about."
Social: **Different ways of being together in research;** **Relations with both peers and competitors;** **Emotional dynamics of interdisciplinary collaboration**	Disciplinary territoriality and status differentials can create interpersonal stress or competitiveness between collaborators (Klein, 1990); Lack of skill in managing interpersonal tensions. For example, by avoiding tensions (Donovan, 2014; Klein, 1996) or seeking premature consensus (Vilsmaier et al., 2017). Alternatively conflicts may escalate, threatening to destabilize a collaboration (Boix Mansilla, 2006; Griffin et al., 2013; Strober, 2011).	"I find it exciting that people are so different and sometimes I overlook the fact that it might also be very difficult." "By trying to satisfy everyone at the same time, we risk not moving the project forward."

Symbolic: **Power differentials and how these manifest in implicit and explicit ways;** **How power dynamics shape values, norms and expectations in a research team**	Asymmetries of power in collaborative research, from those responsible for policy and funding of research to institutional authorities, research colleagues, the researched and users of research (MacMynowski, 2007); Divergent and competing expectations, values and normative orientations across the power hierarchy, operating at the macro level and within a collaborative team (Felt et al., 2012; Ledford, 2015; Lyall, Bruce, Tait, et al., 2011; Schmieg et al., 2017).	"Is it top-down or bottom-up or flat? We're still working on this." "We could have spent more time figuring out difficult issues together, but we had a vocal group who were opposed to process conversations."
Spatial: **Ways in which different spaces enable or constrain collective research work**	Unwieldy physical, institutional, architectural or technological arrangements can obstruct collaborative flow (Gieryn, 2000); Conflicting work space preferences by virtue of differences in culture or working style (Jing Lu, 2015), which can create or exacerbate dynamics of inclusion and exclusion (Knorr Cetina, 1999).	On moving to a new building, "The doors are heavy and the hallways are dark. I feel a bit caged in, which affects possibilities for conversation." Reflecting on the "slump" that followed the move, "We could have addressed problems in the new building more effectively if there had been higher group spirit."
Temporal **Different tempos, time regimes and forms of time in academic work**	Interdisciplinary research projects take more time than individual or monodisciplinary research (Gardner et al., 2014), which can result in awkward trade-offs between efficiency and long-term effectiveness of collaborative research (Felt, 2016); Tension between speeding up and slowing down in response to incompatible demands of urgency and reflection (Cilliers, 2006).	"I think that [lack of time] is forcing people to pull back from collaboration." "I need more time to think than the tempo of decision making in [project] meetings allows, which can result in poor decision making."

Table 8: Challenges encountered in collaborative epistemic living spaces (ELS)

organized according to the five dimensions of a collaborative epistemic living space and illustrated with examples.

In the reality of a collaborative research project, challenges cut across the dimensions of a collaborative epistemic living space. For example, reasonably manageable challenges in one dimension (such as unwieldy spatial arrangements) can intersect with others (such as high levels of diversity and insufficient time), creating knock-on effects (such as poor management of interpersonal tensions), and ultimately manifesting in increasingly divergent research agendas. Treating challenges as multi-dimensional, and treating discomfort as a reminder to ask, "what can I/we learn from this experience?" can help to disentangle the challenges and start to address them. However, if these challenges remain unaddressed, they can continue to compound each other, creating a degree of complexity and subsequent discomfort that can discourage effective and fulfilling collaboration. To avoid challenges overwhelming researchers and compromising their collaborative work, we propose a learning strategy.

4 A strategy for learning to collaborate in interdisciplinary research collaborations

Klein (1996) suggests that a key principle for successful collaborative teams is to be able to learn *in situ* and together (learning as relational) from challenging experiences (learning as experiential). In the interests of operationalizing this principle, we present a learning strategy to support and foster learning to collaborate while collaborating in interdisciplinary collaborations. This learning strategy is twofold and arises from our proposal to think about interdisciplinary research collaborations as multidimensional spaces between comfort and discomfort. The first part of the strategy is the responsibility of those who design and implement collaborative projects and requires that they foster team-wide conditions for learning to collaborate. These conditions help intentionally create an expanded zone for learning. The second part of the strategy is largely the responsibility of individual researchers who join such projects and requires that they are able to capitalize on these conditions for learning. A starting point is to gain greater tolerance for discomfort. The intended outcome is that researchers who encounter challenges that trigger discomfort will be less overwhelmed by them and more able to take advantage of a prevailing team culture that encourages experiential learning from challenges.

4.1 Creating conditions that expand the learning zone of a collaboration

The first part of our learning strategy consists in creating team conditions that optimize opportunities to learn to collaborate while collaborating. We do not address here the more fundamental conditions for collaborative interdisciplinary research shaped by, for example, policy, funding, or institutional culture, which we return to in the conclusion.

Epistemic living space dimension	**Conditions for addressing challenges and learning to collaborate**
Epistemic	Create boundary objects that establish common ground for researchers from diverse disciplinary fields (Klein, 1996). Boundary objects can be overlapping research questions, concepts, methods, fieldwork sites, roles or activities that are "plastic" enough to be molded to a range of needs, and "robust" enough to sustain a sense of commonality (Star and Griesemer, 1989: 393). Boundary objects also offer a starting point for integration and synthesis across different sets of research findings.
Social	Create project structures and procedures that inspire a sense of safety and trust, instead of talking about safety and trust (Kalman, 2013). Over time, use these initial conditions to establish a team culture of "vulnerability-based trust" (Strober, 2011: 128) that supports researchers to openly learn from mistakes in their collaborative endeavors (Edmondson, 1999) and encourages them to explore disciplinary and interpersonal diversity (van den Bossche et al., 2011), taking "leaps of faith" that nourish interdependent work (Hackett and Rhoten, 2010: 425).
Symbolic	Building on these social conditions of sufficient safety and trust, make discussable underlying issues that inhibit collaboration, such as competing values and norms and disciplinary differences in power (Donovan, 2014; MacMynowski, 2007).
Spatial	Create spaces that welcome team engagement. This includes spaces for sufficient face-to-face interaction, proven to be a strong predictor of scientific productivity in teams (Hampton and Parker, 2011) and seating arrangements that signal inclusivity and "destabilize" customary patterns of power (Rabinow, 2011: 137).
Temporal	Create a rhythm and pace of collaborative work that enables a balance of output-oriented tasks and process-oriented tasks, such as establishing a "climate of conviviality" (Boix Mansilla et al., 2016) and reflecting on shared experiences (Baker et al., 2002).

Table 9: Conditions for team-wide learning to collaborate

organized according to the five dimensions of a collaborative epistemic living space.

Table 9 identifies conditions that those who design or implement projects can create in each dimension of a collaborative epistemic living space to intentionally support learning. These conditions are designed to expand the zone for learning as a strategy to address challenges of collaboration identified in Table 8. Drawing together ideas for strengthening collaboration currently scattered across the literature, these conditions thus cover the epistemic, social, symbolic, spatial, and temporal dimensions of interdisciplinary collaborations. In each dimension, these conditions are intended to hold the tension between an under-stimulating comfort zone and an overly disruptive discomfort zone.

Together, these conditions indicate to individual researchers the importance of investing time and effort in working together, and make it inviting to do so. They represent an attempt to create a team atmosphere that offers both ease and stimulation, providing physical, conceptual and process-based approaches to foster collaboration. If collaborative challenges "forc[e] researchers out of their disciplinary comfort zones and into situations where they must balance the need to contribute as experts with the need to learn as students" (O'Rourke and Crowley, 2013: 1939) then these conditions can be mobilized to support experiential learning from such challenges.

4.2 Engaging in collaboration while cultivating collaborative capacity

In the light of evidence that the full potential of interdisciplinary collaboration is not always realized (Roy et al., 2013), there is growing recognition of the need to increase the collaborative capacity of individual researchers (Boix Mansilla et al., 2016; Lyall, Bruce, Marsden, et al., 2011). Thus, in addition to designing interdisciplinary research collaborations for sustainability through learning, it is also important to support individual researchers to develop their collaborative capacity. While collaborative capacity is interpersonal, sometimes referred to as "skills in teamwork" (Norris et al., 2016: 122), researchers in a collaboration can learn individually (following Stokols, 2014). This second part of the learning strategy emphasizes opportunities for a researcher to take advantage of conditions conducive to learning to collaborate.

Capacity can be understood as "the capability to act and the competence to do so effectively" (Clark et al., 2016) and as integrating effective and learnable ways of being, knowing and acting (John et al., 2017; Sipos et al., 2008). Researchers can hone:

- Ways of being (orientations) that increase tolerance for discomfort in the face of challenges, increasing openness to gain new collaborative knowledge and skills;

- Ways of knowing (knowledge) based on insight, understanding and awareness that support collaboration; and
- Ways of acting (skills) that advance collaboration interpersonally practically and technically.

A comprehensive review of collaborative capacities is beyond the scope of this paper. Instead, in Table 10 we match orientations, knowledge and skills (found in the literature on collaborative interdisciplinary research) to the challenges in Table 8. In this way we indicate how particular learnable collaborative capacities can help to address all eleven collaboration challenges. The individual development of collaborative capacity means cultivating new ways of being, knowing and acting in all five dimensions of the shared epistemic living space of an interdisciplinary collaboration. This table provides guidance to researchers to take advantage of conditions that are conducive to learning and to pursue particular orientations, knowledge and skills so that they can collaborate with greater confidence and ability.

Dimension	Collaborative challenge	Collaborative capacity		
		Orientation	**Knowledge**	**Skill**
Epistemic	Difficulties of finding common ground	Combination of a disciplinary training with an "interdisciplinary disposition" (Rhoten et al., 2009: 99)	Learn enough about other methodologies and disciplines to have "justified trust" in their contribution (Fitzgerald, 2012: 5)	Cultivate both "methodological groundedness" and "epistemological agility" for a strong scientific base from which to explore other ways of knowing (Haider et al., 2017: 6)
	High levels of complexity, uncertainty and conceptual ambiguity	Appreciation of, and tolerance for, ambiguity (John et al., 2017; Vilsmaier et al., 2017), complexity and uncertainty (Morin, 1992)	Develop expertise to identify and mobilize boundary objects that can strengthen team coherence in the midst of complexity (Hackett and Rhoten, 2010)	Build thinking skills for engaging with complexity (Cilliers, 2001). Develop skills for dealing with uncertainty (Tauritz, 2012)
	Lack of skill to synthesize and integrate knowledge	Hone commitment to making one's own knowledge accessible to others (Carr et al., 2018)	Develop insight into when synthesis and integration should be done by an individual and when it should involve the collective (Harris et al., 2009)	Build ability and experience in interdisciplinary literacy (Lotrecchiano et al., 2016)
Social	Interpersonal tensions, exacerbated by disciplinary territoriality and competitiveness	Develop appreciation of "… the presence and depth of feelings" in a team for more resilient relationships (Cheruvelil et al., 2014: 32)	Discern the difference between tensions arising from lack of interpersonal and "trans-cultural" awareness (Wiek et al., 2016: 250) and those arising from institutional cultures of meritocracy (Bränstrom-Öhman, 2013)	Hone "social sensitivity" – i.e. a combination of empathy, honesty, clarity, integrity and accountability (Cheruvelil et al., 2014: 33)
	Lack of skill in managing interpersonal tensions	Consider conflict a "normal and necessary part of becoming a high-performing collaborative research team (Cheruvelil et al., 2014: 35)	Cultivate confidence and ability to make tensions available for discussion (Donovan, 2014), looking for insights arising from "epistemic disagreement" (Barzilai and Chinn, 2017: 366)	Develop deliberation, negotiation and conflict resolution skills (Cheruvelil et al., 2014; Wiek et al., 2016)
Symbol	Power asymmetries	Remain alert to how institutional and social rank (including 'race', gender, age, etc.) affects team	Treat leadership as a resource that "relies less on power than on the ability to manage ideation and	Learn to regard differences as meaningful (MacMynowski, 2007) and to harness them to the benefit of the collective (Carr

		dynamics (Bozeman et al., 2016)	creative process" in teams (Palmer et al., 2016: 120)	et al., 2018)
	Divergent and competing expectations, values and norms	Commit to making implicit expectations, values and norms explicit and available for conversation (Ives, Freeth & Fischer, in review)	Develop awareness of own normative orientations; and own professional and social ranking (Felt et al., 2012)	Develop research practices that include pausing and paying productive attention to tacit tensions, including those resulting from restrictive administrative and policy requirements (Reich and Reich, 2006)
Spatial	Unwieldy physical, institutional, architectural or technological arrangements	Become attuned to material conditions, including physical co-location, and their impact on collaborative work (Fischer et al., 2012)	Learn about the relationship between use and arrangement of meeting spaces in order to strengthen group cohesion (Hampton and Parker, 2011)	Use common spaces creatively, establishing an atmosphere conducive to challenging traditional disciplinary and hierarchical academic practices (Hampton and Parker, 2011; Rabinow, 2011)
	Conflicting work space preferences, which can create dynamics of inclusion and exclusion	Pay attention to degrees of belonging within different epistemic groups (Knorr Cetina, 1999)	Develop awareness of personal comfort and sense of belonging, related to physical space, as well as degree of comfort with disciplinary differences (Johansson et al., 2013)	Learn to share work space with people who have different working styles (Jing Lu, 2015)
Temporal	Time consuming nature of inter-disciplinary collaboration	Recognize trade-offs between more immediate outputs and slower but potentially more impactful collaborative outcomes (Lyall and Meagher, 2012; Wasser and Bresler, 1996)	Increase appreciation of the time involved in developing a shared conceptual language and understanding, and allocate team time accordingly (Bracken and Oughton, 2006)	Learn to manage collective time for shared tasks and outputs (Cheruvelil et al., 2014)
	Tension between speeding up and slowing down	Cultivate discernment between "time-wasting" collective experiences and "valuable moments for developing trust" (Felt et al., 2015: 16)	Gain insight into which steps of a collaborative research project should not be skipped for purposes of time saving –e.g. step of creating a shared understanding of the research problem (Palmer et al., 2016)	Develop skills to combine strong empirical practices with reflexive and dialogical research practices (O'Rourke and Crowley, 2013)

Table 10: Collaborative capacities for navigating challenges of collaborative interdisciplinary research

organized according to the five dimensions of epistemic living spaces (ELS)

A final illustration from the Leverage Points project serves to show how mobilizing orientations, knowledge and skills can overcome collaborative challenges. The Leverage Points project encountered a considerable challenge in trying to synthesize and integrate knowledge produced by individual researchers using diverse concepts, disciplines and methodologies. Technical approaches to integration, whether simple or sophisticated, created more confusion than clarity. For several members of the team, a growing sense of discomfort was heightened by the fact that project integration deadlines were approaching. The project management team introduced a series of colloquiums to support integration processes, thus creating conditions to learn together. During this process, the presence of a product designer on the team oriented several of her colleagues to the advantages of a visual approach to knowledge integration. The different researchers produced, for example, simple icons to differentiate 'integration' from 'synthesis', having laboured unsuccessfully to produce shared written definitions. Through participating in workshops with the product designer, these team members gained more knowledge about design methods and developed skill in creating physical artefacts to communicate ideas to each other. This experience supported their decision to adopt a 'graphic harvesting' approach to the final conference of the project, Leverage Points 2019. Key insights from over 350 conference presentations were distilled down to a simple and evocative graphic storyline. A booklet of graphic images that synthesised key conference outcomes, was distributed at the final session of the conference and made available online (http://leveragepoints2019). Gaining a new orientation to knowledge integration and synthesis, and learning new knowledge and skills to support that orientation, created collaborative capacity that benefitted not only the Leverage Points research team, but also members of the broader sustainability community present at the conference.

5 Outlook and Conclusions

In this paper, we have argued that thinking about, creating conditions for, and engaging in interdisciplinary research collaborations for sustainability through the lens of learning can help take fuller advantage of opportunities such collaborations offer. We have pursued this argument by embracing the recognition that interdisciplinary collaborations can be demanding and that researchers are often under-prepared for dealing with the challenges that emerge when collaborating with others. Relying on a literature review as well as on formative accompanying research conducted in an interdisciplinary project in sustainability, we have presented collaborations as multidimensional spaces in which researchers experience varying degrees of comfort and discomfort. We have shown that this way of thinking about collaboration makes it possible to more systematically understand and organize the challenges encountered in interdisciplinary research. Finally,

we have proposed a strategy for learning to collaborate while collaborating: creating conditions in a research project for learning at the team level so that researchers can engage in these project in ways that enhance their collaborative capacity.

Proving that our proposal actually leads to more effective interdisciplinary collaborations is not an easy task. Collaboration effectiveness is a function of multiple factors (Bozeman et al., 2016). Therefore what we have proposed should be seen as one of a suite of strategies to more fully realize the potential of collaborative interdisciplinary research, complementing efforts to, for example, strengthen policy and funding enablers of collaboration (e.g., Gleed and Marchant, 2016), change structural and institutional contexts for collaboration (e.g., Irwin et al., 2018) and reform academic recognition and promotion systems (e.g., Klein and Falk-Krzesinski, 2017). It is, however, possible to track conditions for, and development of, greater collaborative capacity in interdisciplinary teams. We end this article by arguing for the importance of conducting meta-research in collaborative interdisciplinary teams – whether through quantitative studies comparing multiple collaborations, or fine-grained qualitative studies of individual collaborations - to be able to test the contribution of a range of strategies, including the learning strategy presented in this paper, aimed at strengthening collaborative interdisciplinary research for sustainability. Formative accompanying research is an example of a methodology suited to fine-grained qualitative studies of collaboration.

The formative accompanying research methodology combines learning *about* a collaborative research team, with learning *with* and *for* the team (Freeth & Vilsmaier, in review). In practice, this means that a formative accompanying researcher regularly presents what she is learning *about* the collaboration to team members. Together, members of a team explore this material, enrich it with a wider range of perspectives and make sense of their experiences of working together. For example, they might use such a presentation to think together about different sources of comfort or discomfort when working together. This is learning *with* the team. If the team identifies particular challenges of collaboration – epistemic, social, symbolic, spatial and / or temporal – and wants to address these, there is scope for the formative accompanying researcher to be involved in implementing a learning strategy. Such a strategy could contribute to shaping conductive conditions for learning, or support the development of particular collaborative capacities. This is learning *for* the team. An initial three-year cycle of learning about, with and for the Leverage Points team is currently being completed and reflected upon (Freeth, in review).

This article has argued that abandoning assumptions that researchers already possess the full range of capacities for interdisciplinary collaboration can help take advantage of underutilized opportunities such collaborations offer in sustainability research. The

unique strength of our conceptualization and of our proposal consists in the systematic use that we make of learning to collaborate as a strategy to advance interdisciplinary research for sustainability. We conclude that by further experimenting with learning strategies in interdisciplinary collaborations, project leaders and participants might be able to move beyond the generation of "additive multidisciplinary" (Roy et al., 2013) in the future and fulfil the need to create knowledge that capitalizes on the theories, practices, and methodologies of different disciplines. We hope that both concepts and strategies presented in this article will support sustainability researchers in forging teams that are able to overcome the challenges of interdisciplinary and collaborative work and that will inspire them to engage in such collaborations in creative and systematic ways.

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CHAPTER 4

ENGAGING CREATIVELY WITH TENSION IN COLLABORATIVE RESEARCH: HARNESSING THE "I" AND "WE" THROUGH DIALOGUE

Rebecca Freeth*, Elizabeth Clarke*, Dena Fam
* joint first authors

1 Introduction

The authors of this chapter are transdisciplinary researchers working in complex inter- and transdisciplinary projects. Each of us inhabits our own epistemic living space, which means we have our own ways of thinking and making sense of the world (Felt, 2009). This brings together our experiences and understandings from all aspects of our lives. It includes the social and intellectual contexts we are part of including family, community, profession, organisations and cultures.

In writing this chapter, we (the authors) have brought these different epistemic living spaces together to form a collaborative authoring partnership, each contributing unique aspects to the paper, but at the same time forming a whole that is different to the sum of the parts. Our point of connection is an inter- and transdisciplinary research project that combines team members from different ethnic, disciplinary and organisational backgrounds, brought together from around the world with a common purpose of sustainability transformation.

In this book, Brown, Harris and Waltner-Toews propose that individual agency and independent thinking hold an important key to transformation for just sustainable futures. They highlight the power of individuals, such as change agents, thinking independently to question and open up closed social knowledge, where assumptions, values, beliefs and understandings are otherwise tacit and unquestioned.

This is also the case in research projects embedded in the academic communities in which each of us works. On the one hand, there is the "I" of research: individual scholarship and inquiry, and on the other hand there is the "we": the collective and collaborative

epistemic living spaces that researchers inhabit. We use the term epistemic living space because the diversity of researchers cannot be described only by looking at their disciplinary backgrounds; it also needs to include all aspects of their knowledge and experience, including social, political, physical, institutional and personal.

The ideas of interdisciplinarity and complexity have become increasingly entwined (Klein, 2004). Klein and Newell (1997 in (Klein 2004, p. 2)) describe interdisciplinary study as "a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession." The complex intractable wicked problems of the Anthropocene era are challenging all of us, and specialist and "expert" thinking alone is no longer sufficient.

Traditionally in research, the "we" has been characterised by relatively closed communities of practice. In recent years, these have been challenged by a growing number of inter- and transdisciplinary endeavours that are arising in response to the wicked problems of the Anthropocene, where boundaries of communities of practice are breached and there is an increasing need for more heterogeneous epistemic living spaces embracing multiple kinds of knowledge.

There is growing (but not universal) acceptance of the need for a greater diversity of approaches to tackling wicked problems (Australian Public Service Commission, 2007; Head and Alford, 2008; Rittel and Webber, 1973). There is also a need to examine the characteristics of and relationships between, individual thinking and agency ("I") and collective and collaborative approaches ("we"). We are interested in how this relationship can be used to constructively tackle wicked problems, and contribute to a just and sustainable future.

In this chapter, we explore the tensions around the "I" and "we" paradox, and how they emerged within our collaborative research project. Through a series of significant project events, we describe the ways in which these tensions emerged, how we responded to them, and the consequences and outcomes of these responses. In particular, we examine how this tension shapes and is shaped by (1) the 'wickidity' of the problem, (2) the level of self-organisation and adaptation in our individual scholarship and (3) the degree of heterogeneity of the epistemic living spaces of the various constellations and combinations of the "we" of team work.

The key events in the project that we draw on include the annual all-team retreats and a series of outcome mapping workshops. Our data includes participant observation notes and a series of semi-structured interviews with other project team members.

2 Exploring the paradox of "I" and "we" for collective coherence

A paradox is a seemingly contradictory situation that resists simple resolution. A paradox contains two or more elements, like the "I" and "we" in interdisciplinary projects, that appear to be mutually exclusive and that appear to operate at the same time (Kahane, 2010). A problem has a solution, whereas Bohm (2004: 73) warns "if the mind treats a paradox as if it were a real problem … the mind is caught in the paradox forever."

Brown & Harris (2014) emphasise the importance of reframing our ideas of paradox and the tensions they create, and the need to look at relationships between opposites, including individuals and society, parts and wholes, stability and chaos, and rationality and creativity. In the words of Bateson (2014, p.83) "reflection on the patterns that connect is more important than concentrating on the differences that divide". This provides an alternative to the "binary logic that dominates modern Western thought and the problem of paradox that it creates" and "fosters the development of creative and innovative mindsets" (Wickson et al. 2006, p. 1054).

Research teams are increasingly recognizing and engaging with the paradoxes and tensions associated with wicked problems. The particular challenges of these problems require a shift away from the traditional modes of research where individual researchers ("I") work in relatively homogeneous teams, and are guided and bounded by a socially constructed knowledge of a community of practice of like-minded scholars, who share methodological framings and understandings. In these cases, coherence is relatively easy. This also applies to multi- and pluri-disciplines, where compatible disciplinary knowledge areas are combined, and the emphasis is on juxtaposing, sequencing and coordinating knowledge and approaches (Max-Neef 2005, p. 6; Klein 2010, p. 16).

By contrast, bringing together an inter- or transdisciplinary team surfaces differences in epistemic living spaces, but most particularly in methodological framings and understandings, which immediately escalates tension, and can lead to considerable intellectual and emotional discomfort (Smith and Berg, 1987). There are broadly two possible responses to this discomfort. Firstly, by avoiding or dissipating tension through a siloed or "additive" multidisciplinary approach, where individuals continue with their scholarship and connect with their disciplinary community, creating a fragmented approach (Roy et al., 2013).

The second possible response is that team members can give the "I"-"we" paradox "serious and sustained attention" (Bohm, 2004: 75) and gain insight into the contradictions and the conditions that create them. In this case, individuals can exercise individual agency through independent creative thinking ("I"), as well as engaging with

the interdisciplinary team through collective thinking ("we"), which requires a greater engagement with difference. Here, the emphasis is on integrating, linking, focusing, blending, transcending, transgressing and transforming (Klein, 2010). This latter approach is potentially paradoxical and creates its own tension, as the individual is at the same time acting as a free and independent, self-organising agent within the project, while at the same time connecting, relating and contributing to the team effort through collective coherence.

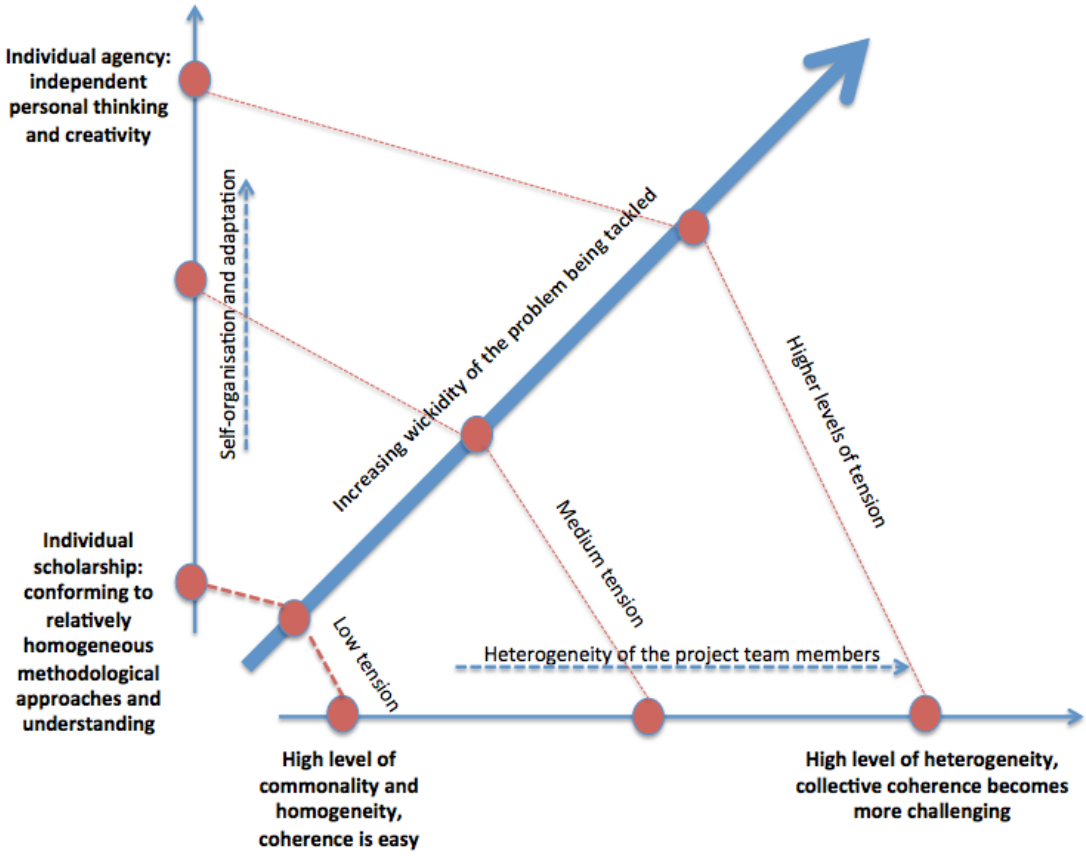

Figure 9: Navigating the tensions between the "I" and the "we" in research.

Navigating the tensions between the "I" and the "we" in research. With increasing wickidity of the problem being researched, the greater the need for individual agency and independent thinking and creativity, along with the need for increasing heterogeneity of the combined epistemic living spaces of the team.
This in turn increases the level of tension between individual approaches ("I") and collaboration ("we").

Collective coherence infers a sense of unity where two or more different things or ideas are present, and generates the "confidence of feeling grounded and … that promotes a

willingness to act …” (Letiche et al. 2011, p. 392). It is not consensus, but instead infers an approach that embraces diversity of understanding, and requires dialogical approaches, pattern recognition and reflexivity. Collective coherence enables a group to develop a shared (but not necessarily homogenous) understanding of reality, which is described by Craig Ashhurst in his Chapter of this book.

3 Navigating the “I” and “we” tension in a complex inter- and transdisciplinary project

For illustration, we turn to a case study of the collaborative process in a project in which each of the authors has been involved. This project, based at a German university, is a latticework of inter-, trans- and disciplinary research aimed at tackling some of the most intractable challenges of sustainability through institutional restructuring, reconnecting humans and nature, and rethinking how we understand and act in the world. The co-located interdisciplinary team comprises 23 individuals from multiple disciplinary, geographical and linguistic ‘homes’. Transdisciplinary engagement includes collaboration with partners from outside the academy (Brown, 2010; Klein, 2014; Lang et al., 2012; Thompson Klein, 2004).

We use this example as a way of thinking about enhancing engagement with the “I”-“we” paradox in a research context, through our experiences and observations in this project. The diversity of the team and the initial problem framing created challenges as well as opportunities for members of the project team. On the one hand we were being exposed to new and exciting ideas, visions of sustainability and research methodologies. On the other hand, we struggled with the shift from individual scholarship embedded in disciplinary and multi-/pluri-disciplinary thinking, to the tensions associated with higher levels of individual agency combined with higher levels of team heterogeneity (Figure 9).

While most members of the project are strongly oriented towards interdisciplinarity, this does not necessarily mean that they also have a preference for collaboration. For example, one team member expressed their affinity for interdisciplinarity as “I don’t know anything else”. Later, when describing their orientation to collaboration, the same person stated, “I like doing my research independently and I like having full ownership over my research.” As Klein (2010: 19) notes, “Many believe that interdisciplinarity is synonymous with collaboration. It is not.” We believe that individual agency – expressed as independent thinking or taking initiative and leadership – is a necessary ingredient of interdisciplinary research collaborations, as long as the “I” of the individual researcher remains in a healthy tension with the “we” of the research team.

Where researchers in the project team have a preference for collaboration, a clearly demarcated difference became evident in terms of whether this is with one other person, a small group or the full project team. In other words, there are multiple constellations of "we". Between the "I" and the full team "we", it is possible to opt for collaborating with one other person or in a small group of researchers. We have learned not to assume that someone with a strong orientation to collaboration necessarily wants to work in a group, big or small, as the following quote from a colleague indicates: "It's quite easy to quickly adjust to people's responses and reactions when it's between two people, but doing it with eight people is much more tricky." Specific criteria usually guide these choices, such as: "I prefer to work with a small group of people who are dedicating the majority of their effort to that collaboration."

At different stages of the project, the "I" and "we" orientation varied between the low tension option of individual scholarship and relatively homogeneous backgrounds and contexts of multi-/pluri-disciplinary collaboration, and at the other end, individual agency, creativity and independent thinking and more heterogeneous team engagement and collective thinking mode (see Figure 9).

To illustrate these shifts and changes in the "I" and we" orientation and some of the drivers, we focus on a series of significant events in the project, beginning with the start-up phase of the project, in which the project grew from a nascent "we" of eight Principal Investigators (PIs) to the full 23 team member "we". Then we sketch a narrative of three milestone collective events in the project: our annual team retreats. These reveal significant patterns and insights into the team's negotiation of the "I"-"we" tension.

The eight Principal Investigators / professors in the team tell the story of collectively designing the project. This was an intensely collective endeavor and, for some, a career highlight because of the intellectual stimulation and trust it generated. A combination of individual agency and collective thinking resulted in a strongly reasoned project document that won funding support and attracted a team of researchers from all over the world. It produced a conceptual framework for the project that seemed, in the words of one of its creators, "so neat and coherent".

That early experience of coherence between the Principal Investigators was disrupted almost as soon as the full team had been recruited. Firstly, the Principal Investigators and post docs met to develop a glossary of key terms. This turned out to be a more difficult and incomplete exercise than anticipated, disturbing the sense of epistemic coherence. Then the full team started to interact, which significantly increased the experience of group heterogeneity. As one of the project leaders put it, "When it was just eight of us, it was quite contained because it was just us dealing with the consequences and we can get on with it. Then we bring in 12 different personalities and you've got how those 12 work

with each other and how they each work with their Principal Investigators, which changes how the Principal Investigators work with each other.” The dissonance between the desire to create a flat hierarchical structure in the project, and the hierarchical nature of academic institutions, meant that it proved difficult for any one person to exercise individual agency in a way that provided direction in these early experiences of divergence. In addition, the multiple institutes in which team members were located administratively created identity questions for the research colleagues, given that each institute has a different focus, methodologies, combination of disciplinary expertise, ways of interacting and reward structures.

Three months after the official project start date, the full team met for the first time for a project retreat and the “I” and “we” paradox made a strong appearance. Most of the PhD candidates had just completed their first task of the project, which was to develop their research proposals. Tension manifested between the PhDs’ freshly conceptualized individual research project proposals and how their research fitted into the three dimensions of collective research: the place-based case studies (for collective transdisciplinary research work), the research integration process, and the project as a whole.

During the course of the retreat, this tension intensified. The locations of the transdisciplinary case study, and the topics and partners had not yet been finalized and PhD members of the team were concerned whether the individual research agendas to which they had already committed would fit with the transdisciplinary research agenda. If not, what would this mean for the integration process and would they still be able to contribute to the overall project as envisaged? In a bid to address the growing tension, expressed as rising levels of confusion and frustration, the project leaders met and then announced three decisions. Firstly, that the PhD candidates should prioritise their individual research. They were encouraged to find a way to contribute to the transdisciplinary work, but this would largely be the responsibility of their supervisors. It was acknowledged that making a retrospective fit was not ideal and might not be feasible. Secondly, that PhDs would not be involved in selecting case studies, on the basis that this would place an unfair degree of responsibility on them. Lastly, that responsibility for integrating the different work packages and realizing overall project goals was the task of the PIs and post-docs, not the PhDs. One of the project leaders stated, “The most important thing for the PhDs is that you get a PhD out of this project and you don’t feel responsible for the overarching project”.

From the perspective of the “I”-“we” paradox, these decisions indicated that PhDs should (1) prioritize individual scholarship over collective thinking; and (2) prioritize individual

scholarship over individual agency. This also sent a clear signal about diminishing agency for the PhDs in general.

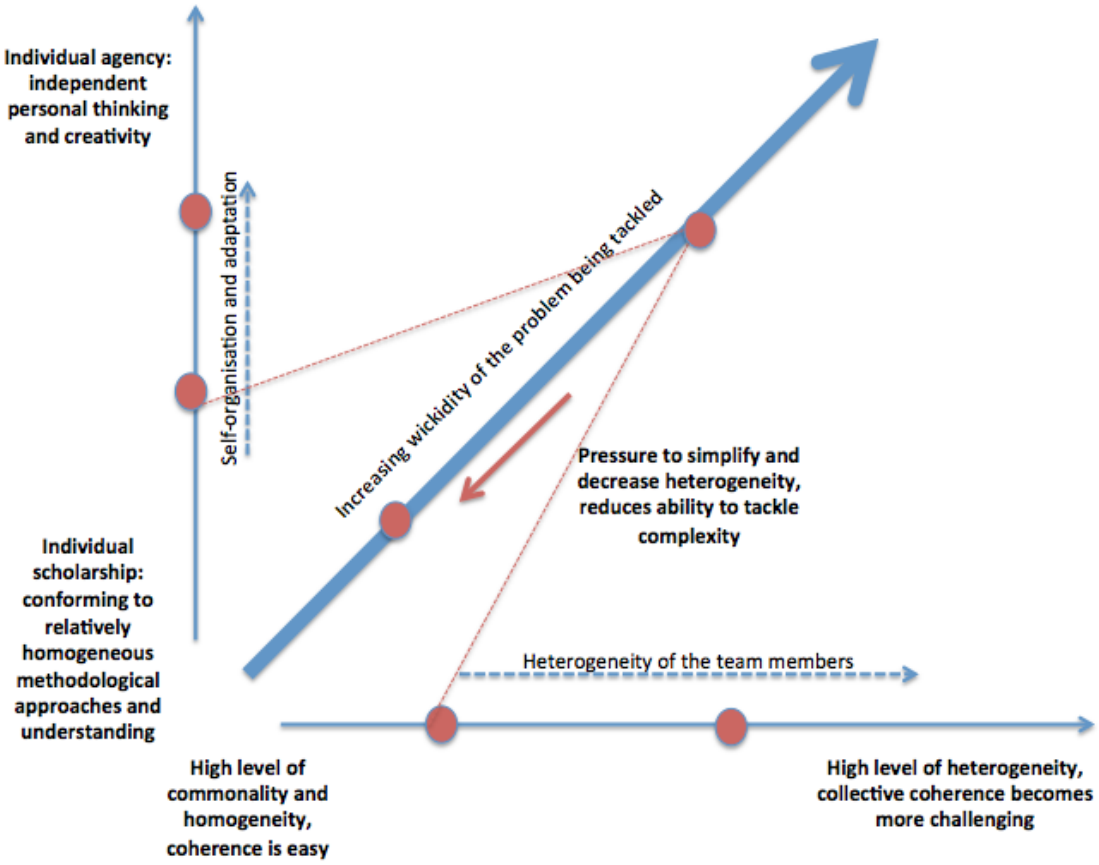

Figure 10: The first team retreat: Navigating the tensions between "I" and "we".
The tension was diffused and avoided by focusing on individual scholarship. This resulted in increasing pressure to simplify and reduce heterogeneity, making it more difficult to deal with wicked problems.

Trying to dissolve the "I"-"we" tension in this way had two unintended implications for ongoing navigation of this paradox. Firstly, it created a new tension between a more staid, individual scholarship approach and aspirations to blaze an intense trail of inter- and transdisciplinary collaboration and integration. Secondly, it initiated a pattern of prioritizing individual thinking early in the project that repeated during the ensuing months and years. This pattern has made collective coherence much more challenging. Figure 10 illustrates this strategy of trying to manage tension by retreating to

homogeneity and individual scholarship, while trying to tackle a wicked problem, with the resulting increase in tension and pressure to simplify the problem focus.

A year later at the second retreat, there were heated exchanges about the task of research integration, particularly when we discovered that we had divergent ideas about what integration meant, how to do it and whose responsibility it was. Some of us highlighted the process of integration while others of us highlighted the products of integration, and there was a difference of opinion about whether the integration outcomes should be emergent or more tightly planned and managed.

After the retreat, there was little follow-up on the topic of integration. The tension was avoided. Some members of the team wondered whether integration had been dropped altogether. One of the authors discussed this with a PI, who said that although integration remained a priority, the “negativity” it seemed to provoke at the retreat had made them reluctant to mention the word at all.

Over the course of the first two retreats, patterns to diffuse or avoid tension were established. However, the paradoxes that caused the tension did not go away. At the start of the third retreat in 2018, the pattern of diffusion and avoidance was repeated when we encountered divergent opinions on key concepts. On each occasion, before tension could build, a PI proposed a way forward that involved bypassing the issue. Both used the word “avoid” to motivate their proposal. The pattern was well and truly in evidence.

However, in the afternoon session, there was a change. Three boundary objects had been introduced as central concepts for the overall project for the purpose of enhancing collective coherence. These boundary objects are key concepts that are flexible enough to be accessible for a range of epistemic understandings, but at the same time sufficiently immutable to create anchors to connect different understandings (Akkerman and Bakker, 2011; Star and Griesemer, 1989). There had been significant dialogue on these boundary objects in the lead up to the retreat.

The boundary objects in this project related to the concepts of “transformation”, “systems thinking” and “collective and transdisciplinary research practices”. In the afternoon session, there was an extended discussion among small groups about these boundary objects and how they related to their own and their colleagues’ work. The resulting discussion became an engaged and open dialogue, opening up the possibilities of engaging the “I” and “we” tension more constructively. These discussions allowed individual researchers to engage in a dialogue with their colleagues to share their own vision and ideas for their research around the shared boundary objects. The general

feedback about this exercise was very positive with one researcher stating “this is the best conversation I’ve had in the whole project”.

On the second day, with not much time left before closing, there was a facilitated session to identify and plan collective activities in pursuit of research integration. The format was a full-team plenary conversation, sitting in a semi-circle of chairs. The team hit a difficulty fairly early on; some people were ready to dive in and contribute their ideas, while others wanted to understand the parameters of the conversation. The enthusiasm of people with ideas started to flag. Noticing this, the facilitators framed what they saw: “We are a diverse group; we have different needs and we work at different paces. Some people want to contribute but won’t be able to until they fully grasp what they are contributing to. Could those who are ready, but getting frustrated, stay engaged long enough that we’re all on board?” In other words, could we stay in the tension? There was agreement to do so and within the hour we had created a satisfying list of ambitious but realistic collective activities, which were then filtered through a series of unanimously approved criteria to produce a prioritised short-list, with decisions about how to proceed. A week after the retreat, a comprehensive plan was presented back to the full team for discussion, in a meeting that produced high energy, clarity and goodwill.

Despite the diminution of individual agency experienced at the first retreat, subsequent responses of the PhDs differ. Some are exercising individual agency in support of the overall project, realizing its collective goals of meaningful collaboration (process) and deep integration (content). In so doing, they are choosing to remain in the “I”-“we” tension, to the benefit of collective coherence. In contrast, some members of the team are exercising individual scholarship with minimal engagement in the collective coherence. Rather than staying in the tension of the apparent contradictions between the “I” and “we”, they see it as a choice between “I” or “we”. As the final year of the project progresses, it remains to be seen how effectively the project team will be able to continue to constructively and creatively engage in this tension.

4 Embracing tension in collective thinking through dialogue

Reflecting on the events of the project so far prompts questions about how, when and why the team was able to engage with the tension associated with the paradox of “I” and “we” in the project. Introducing dialogical practices (and making time and space for them) has been an important process for strengthening both individual agency and collective thinking. The practices bridged more diverse epistemic living spaces, enabling a greater focus on the ambitious and exciting overall goals of the project. In this section, the

authors discuss and analyse the role of dialogue for constructively engaging tension for collective coherence.

Table 11 presents four ways of engaging conversationally with paradox in groups, progressing from serial monologue to generative dialogue. The first two ways (serial monologue and engaged monologue) enable expression of individual perspectives. There is an important place for this in collaborative research teams. Each researcher comes to the collaborative process with a creative "mind of one's own" and valuable experiences of exercising that mind in order to realize a research agenda. The group as a whole benefits from exposure to each person's viewpoints. Individual perspectives tend to be delivered in a presentation format in the academic environment (serial monologue) and are then subject to debate (engaged monologue) so as to strengthen each other's thinking. Individual agency is welcomed as an important resource to the collective. The first two project retreats prioritised this kind of exchange, so that we learned about each other's research interests, methodologies and agenda, and sought to make them more robust.

However, in the context of tackling a wicked problem, serial and engaged monologue is not enough. In collaborative interdisciplinary research, it does not provide a way of navigating the kinds of paradox and tension that such research teams encounter. In a serial monologue, the tension between different methodological approaches and understandings can make team members uncomfortable, and this can result in withdrawal, after which the tension becomes slack and the paradox becomes less visible. This release from tension for team members is likely to be temporary, however. In an engaged monologue, the clash of polarised perspectives may create an almost intolerable degree of tension, which can render the issues behind the paradox undiscussable (Donovan, 2014).

"Interdisciplinarity is not a monologue" states Klein (1996: 216), reiterating Bakhtin's critique that monologue fails to bring different perspectives into meaningful conversation (Nesari, 2015). This holds us back from deepening our individual and collective understandings of wicked problems. Monologue also closes down opportunities to deepen our appreciation of each other, allowing us to dwell in stereotypes and myths rather than learning from our differences (Baker et al., 2002). This can result in heightened incoherence (Bohm, 2004).

In the academic context, which continues to reward individual scholarship and achievement over collective scholarship (Weingart and Padberg, 2014), there is value in harnessing individual thinking and agency to enrich collective thinking and agency. If we only have individual thinking and agency, this can create a degree of incoherence that becomes unworkable in a team environment.

As an antidote to incoherence, dialogue can enable us, collectively (i.e. “we”), to examine and address fragmentations, abstractions, assumptions and prejudices incubated in the individual mind (Bohm, 1992, 2004). Moreover, dialogue makes it possible for individual and collective thinking to co-exist, productively activating the “I”-“we” tension so that new or renewed collective understanding emerges out of the exchange of individual ideas. Dialogue is “an intersubjective process whereby an individual maintains a sense of self while at the same time is aware of and open to the influence of others.” (Baker et al., 2002). Bohm (1992) claims that dialogue has greater potential than any other methodology to generate shared meaning, which does not necessarily imply consensus. Indeed, emergence of greater interpersonal understanding and meaning can develop either by moving towards convergent thinking or sticking with the frustration of divergent thinking. Interdisciplinarity in collaborative research has potential to be a dialogue, enabling a flow between a mind of one’s own and collective coherence.

Returning to Table 11, the third (reflective dialogue) and fourth (generative dialogue) ways of engaging with paradox in groups represent constructive approaches to address the tensions inherent in paradox. Reflective dialogue involves curiosity about others’ perspectives, with an interest in understanding what makes them different from one’s own. The tension is held as the polar ends of the paradox are explored. Strengthening the “I” paradoxically strengthens the collective. As collective understanding dawns, there may be a sense of temporary resolution of the tension. This is what Process Work calls a ‘cool spot’ following a ‘hot spot’ in group dialogue (Mindell, 2007). Although the contradictions that produce the paradox will probably remain, they become more accessible for ongoing engagement.

The fourth option, generative dialogue, is sometimes possible. In generative dialogue, members of a research team stay engaged with high levels of tension and hence open up windows onto new insight, showing the paradox in a new light and holding potential for deep collective coherence.

Ways of engaging	Characterised by	High tension results in	Implications for tension	Implications for paradox
Serial monologue	Turn-taking in telling own perspective; talking in order to be heard; Mode: Downloading, advocating or presenting	Withdrawal: to reduce tension and avoid conflict Outcome: Return to one's own perspective	Tension sags	Paradox becomes invisible but does not go away
Engaged monologue	Exchange of own perspectives; Involves listening; Mode: Competing or debating	Clash: To be right and prove the other wrong, or to defend own view Outcome: Hardened different perspectives	Tension increases, possibly to breaking point	Paradox becomes highly charged, which can result in either protracted conflict or avoidance
Reflective dialogue	Exchange to learn about other perspectives; Involves inquiry, self-reflexivity and empathy	Engagement: to explore own and others' assumptions and more deeply understand	Tension is held, with potential to be (temporarily) resolved	Paradox becomes more familiar and manageable
Generative dialogue	Emergent exchange with other perspectives and with the bigger picture that created the paradox	Breakthrough: Staying with high tension catalyses a paradigmatic shift and sense of collective flow	Tension is transformed into new awareness	Paradox becomes a source of new insight and learning, and generates collective coherence

Table 11: Four ways of engaging with paradox in collaborative groups.

Adapted from Scharmer (2008); Kahane (2008); Ashhurst (pers. comm.)

As a project team, we have begun to include dialogical ways of engaging with each other about our individual work and the paradoxes we experience in our collective work. In the process, we have started to shift away from patterns of withdrawal and avoidance, and are developing a higher tolerance for collective tension. Learning to navigate the “I” and “we” more adroitly has potential to create more synergy between the mind of one’s own and the collective mind, which enhances collective coherence.

Nevertheless, despite the proliferation of complex, inter- and transdisciplinary research projects and the associated benefits of individual empowerment and collective coherence, dialogue practices and skills are not yet well established in many research settings. Dialogue processes may be treated as inimical in research settings that prize concrete output above all else. There is rich opportunity in learning to pursue the promise of dialogue in ways that concretely support collective learning outcomes.

5 Conclusion

The biggest challenge for us as we navigate the wicked problems of the Anthropocene and strive for sustainability transformation is to not only gain the best from each individual but also to invite them into the collective. This quantum effect is possible. To achieve this, each person needs to feel safe, inspired, comfortable, uncomfortable, challenged, appreciated, trusting and trusted.

Our strategy for this is to pursue the promise of dialogue, which can make visible the various paradoxes and accompanying tensions. When such tensions are hidden or avoided, individual agency and collective coherence will be difficult to achieve. Discussing and reflecting on these core issues is not a distraction from the real work of research projects, but should be considered an essential part of process, outputs and learning.

Strong individual agency should mean it is possible to be decisive and to contradict without fear of repercussions and with a sharp edge to rule out complacency. In addition, somewhat paradoxically, being part of a collective mind (as distinct from group think) adds to the richness of collaboration. In this way, we believe the giant leap may be possible, and we can see ahead the glimmer of a more just and sustainable future.

As the research project draws towards its conclusion, we look forward to hosting an international conference. At the time of writing, we are exploring ways of using dialogue to broaden engagement in a larger forum about necessary shifts in thinking and approach for transforming towards sustainability.

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CHAPTER 5

ADVANCING COLLABORATIVE INTERDISCIPLINARY RESEARCH: LEARNING ABOUT, WITH AND FOR A RESEARCH TEAM

Rebecca Freeth

ABSTRACT

When collaborative interdisciplinary research for sustainability falls short of realizing its tantalizing potential, what can be done? There are multiple strategies to address challenges that threaten to undermine collaboration. These range from leveraging change at structural levels, focusing on research policy, funding and institutional remedies, to leveraging change at educational and interpersonal levels, focusing on researchers. A strategy at the team level is to create a specialized role within an interdisciplinary team, for learning to collaborate alongside the researchers. This article reflects on three years of research within an international collaboration comprising natural and social scientists. The methodology we developed, called Formative Accompanying Research (FAR), has potential to learn *about*, *with* and *for* a collaborative research team. I outline this methodology and explore the team's learning responses to the presence of a formative accompanying researcher in the team. The article ends with recommendations, directed to researchers who design and implement interdisciplinary research projects, for optimizing such a learning role in the interests of advancing collaboration for sustainability.

1 Introduction

A defining feature of sustainability research is its commitment to collaboration. Not only is collaboration considered necessary for researching complex social-ecological systems (Bammer, 2008; Barry and Born, 2013; van Kerkhoff, 2014), but it is also an enriching and invigorating experience for the researchers (e.g., Parker & Hackett, 2012). However, collaborative research can be "unabatedly demanding" (Defila and Di Giulio, 2018: 101) and fall short of realizing its potential (Lang et al., 2017; Piso et al., 2016; Roy et al., 2013). The multiple impediments to interdisciplinary collaboration are well documented and range from outmoded scientific cultures to institutional arrangements more suited to disciplinary endeavour, as well as difficulties, disagreement and discomfort at the level of the team (Martin and Pfirman, 2017; Philips et al., 2013; Weingart, 2014). Team difficulties may have epistemic features such as use of non-compatible methods, or social features such as discordant working styles (Felt, 2009; Freeth & Caniglia, in press). Regardless of the reason, if impediments to interdisciplinary collaboration threaten to undermine sustainability research, something must be done.

There is a growing list of interventions to address such impediments, encompassing reform of the structural and institutional conditions in which collaborative interdisciplinary research takes place (Gleed and Marchant, 2016; Irwin et al., 2018; Klein and Falk-Krzesinski, 2017), adaptation of sustainability curricula for training effective collaborative researchers (Caniglia et al., 2018; Stokols, 2014; Wiek et al., 2016), and development of self-awareness and personal resilience of researchers who seek to work collaboratively (Hedlund-de Witt et al., 2014; Lang et al., 2017; Wamsler et al., 2018).

In addition to these strategies, there is the option of creating a meta-research role to address collaboration at the level of the team. This role is variously described as an intermediary, translator, organizational ethnographer, science and technology studies (STS) researcher, or accompanying researcher. To give these disparate roles a collective term, I borrow Gauttari's (2015: 135) language of "research into research", which he proposed for deepening interdisciplinary research and more fully realizing its potential.

In 2014, a group of social and natural scientists in the sustainability faculty of a German university designed a collaborative interdisciplinary research project that would ultimately involve 23 co-located researchers from around the world. The project included a role for conducting Formative Accompanying Research (FAR), a version of research into research. The FAR role entailed being a member of the collaborative team for the duration of the research project, responsible for two tasks: to deepen understanding of interdisciplinary knowledge production by combining theory with empirical research; and to use this understanding to "inform, shape and improve" the team research process

(project description, 2014, p. 19). I was recruited to the FAR position in the capacity of a PhD candidate. Together with a colleague in the project, I framed the FAR work through three research and learning orientations: learning *about*, *with* and *for* the team. This emphasized the relational quality of research into research, as well as the dynamic quality of movement between these three learning orientations. Initially, we focused on the implications of these learning orientations for the formative accompanying researcher, leading us to propose and implement practices to navigate FAR positionality (Freeth & Vilsmaier, in review).

This article pays attention to implications of these three learning orientations for the team. I reflect on my experience of the team's learning response to a formative accompanying researcher and its readiness to engage with FAR. I do this as the project draws to a close. My goal in reflecting on this experience is twofold: 1) to gain further insight into FAR practices, as an example of research into research, and 2) to gain further insight into the practice of collaborative interdisciplinary research for sustainability so that it can be strengthened, rather than be debilitated by, inevitable difficulties, disagreements and discomforts. Thus the intended contribution of this article is to inform how academics who design and implement collaborative interdisciplinary research projects can foster conditions to take advantage of research into research as a strategy for advancing collaboration. It is expected that the insights and recommendations in this article will have applicability beyond the field of sustainability research.

In pursuit of these goals, I introduce FAR, locating it in a landscape of research into research methodologies (section 2). While aspects of this methodology are evident throughout the article, section 3 summarizes the empirical research strategy for learning about, with and for the team. This creates a backdrop for relating the team's response to FAR (section 4). In section 5, I explore implications beyond our own project, leading to recommendations for academics to strengthen the collaborations for which they bear responsibility.

2 Research into Research

Researchers working in teams may not be able to give their experiences of collaborating – rewarding and challenging – enough attention to learn from them. There are several reasons why this could be the case, including researchers being pre-occupied by the research tasks and deadlines at hand, or being unaccustomed to reflective research practices, or not being attuned to interpersonal dynamics of working together (Read et al., 2015; Thompson, 2009). Where there are difficulties, these might go unaddressed because they seem to be under the surface and thus inaccessible (Margolis, 1993; Stone,

2013; Strober, 2011). Even where there is sufficient awareness of difficulties, team members may not yet possess sufficient skill to address their causes (Cheruvelil et al., 2014; Galway et al., 2016).

Against this background, there is growing acknowledgement of the merits of creating an additional role in teams, which can pay sustained attention to processes and outcomes of collaboration, and potentially, provide support in addressing difficulties (Balmer et al., 2016; Fitzgerald et al., 2014). This role is in evidence in research environments, as well as the corporate sector (Long et al., 2013) and multi-stakeholder collaborations for social change (Fowler, 2014; Kahane, 2010). In the research environment specifically, there is potential for such a role to enhance learning *about*, *with* or *for* the researchers. The preposition matters, indicating the primary rationale for such a role in a research team, and the kind of relational proximity (nearer to or further away from the team) that serves this rationale. Learning *about* has the epistemic goal to create transferable results, pursued in the role of scientific researcher. Learning *with* has the goal to learn *in situ* alongside the team, in the role of a team member. Learning *for* has the goal of supporting the team to advance its research outcomes, in the role of an intervener. An intervention could, for instance, involve strengthening team members' confidence and skills for dealing with the kinds of collaborative challenges they face (Freeth & Caniglia, in press). The question of intervention deserves more attention than I can give it here. Suffice to acknowledge that there is a spectrum of intervention, starting with the mere presence of a formative accompanying researcher in a team, and that more intentional forms of intervention are not to be embarked on lightly in the process of conducting research into research (Balmer et al., 2015).

The way I present research into research implies a close relationship between research and learning. I assume that the purpose of research is not just to produce knowledge, but to promote understanding and learning (Senge & Scharmer, 2006; Freeth & Caniglia, in press). A further differentiation is warranted, between learning and evaluation. While evaluation methodologies can lead to learning outcomes (Luederitz et al., 2016), too often these become secondary to accountability outcomes, which tends to limit the kind of open curiosity implicit to learning (Felt, 2017). The types of research into research considered here (including FAR) do not extend to evaluation, an entire field in itself, for this reason.

The following broad patterns can be discerned between different methodologies of research into research. Some approaches related to STS, including science studies (Jasanoff, 2013) and certain forms of ethnography (Garforth, 2012; Parker and Crona, 2012), are primarily for learning *about.* In contrast, embedded research is primarily about learning *with* the team (Taylor et al., 2017)(Olivier et al., 2017) with the rationale to

enable better quality knowledge co-production (Hackett and Rhoten, 2010). Lastly, bridge builders such as intermediaries (Jeffrey, 2003), research translators (Carlile, 2004; Huzair et al., 2013), facilitators (Öberg, 2009; Palmer et al., 2016; Rogers et al., 2013) are present primarily to learn *for* a team. Aspects of this learning *for* role are currently being codified as interdisciplinary fields in their own right (e.g. integration and implementation science (Bammer, 2006, 2017) and interdisciplinary translation and integration science (Hess, 2018)).

We have conceptualized FAR as a methodology that combines all three learning orientations, involving a dynamic practice of moving between the proximities implied by learning *about*, *with*, and *for* collaborative research teams (Freeth & Vilsmaier, in review). In this respect, it bears several similarities to Defila and Di Giulio's (2018) approach to accompanying research, which also focuses on collaboration for sustainability. However there are three main differences. Defila and Di Giulio envisage accompanying research being conducted from a more distant location than FAR, such as by external consultants, and involving less mobility between the three orientations. Accompanying research also treats learning *with* as joining the research team in their investigation of the research topic at hand. This begs the question about what we mean by 'formative'. Coupling 'formative' with 'accompanying' emphasizes being alongside an unfolding research process, which creates prospects for helping to shape it while it is still in formation (Reigeluth and Frick, 1999). Thus the emphasis of FAR is to learn *with* a team (in its process of becoming) and *for* a team (to promote its successful development) while learning *about* it.

3 Methodology

This section describes a research strategy to FAR that sought to learn *about* the team in ways that would also create possibilities for learning *with* and *for* the team. The research design followed a qualitative mixed methods approach and an abductive logic (Stuart, 2018). I gathered data over the course of three years, conducting semi-structured interviews with members of the team and participant observation of team gatherings, both formal (such as meetings and retreats) and informal (such as tea and lunch breaks together). Maintaining a weekly research journal enabled me to perceive patterns over time and reflect on what they might indicate. One of the patterns I tracked was my own proximity to the project. When I noticed that I was getting too close, so that what I was observing was becoming blurred, I would start to move in the other direction. When I was too far away, signalled by a sense of disconnect from the project, I would start to move inwards again. Having a desk in the project offices and another desk elsewhere on campus helped to make adjustments to my physical proximity over the duration of the

project. A stronger physical presence created more opportunities for impromptu conversations in the corridors and kitchen. These conversations provided a valuable backdrop to help make sense of developments in the project as a whole.

In my initial data collection about the team's experiences of collaborating, I was guided by a grounded theory approach in which I followed all available trails for several months until I was ready to add the filter of sensitizing concepts (Clarke, 1997). Many of these sensitizing concepts arose from an initial consultation with the team about what they hoped to learn through FAR and included, for example, interest in 'communication', 'integration', 'trust' and 'differences'. The filtering process started to direct me towards stories about collaboration experiences, where there was already considerable theory to draw on. This precipitated a shift towards narrative methods for working with the data I was gathering (Czarniawska, 1997; Riessman, 2008). Narrative also became a preferred way of 'telling' my research findings in articles and presentations, both to the team and wider audiences.

I made regular presentations of preliminary results of FAR to the team (six over three years), using these opportunities to request feedback on the methodology, share initial findings, test tentative interpretations and invite joint meaning making. In these presentations, I kept open the option of conducting a learning intervention to address any gaps identified through FAR, and emphasized that the initiative for such an intervention would need to come from the team instead of from me.

The results in this article derive from my field notes, interviews with colleagues and my research journal. My interpretation of these results has been enriched in conversation with members of the team and through their responses to drafts of this article. Thus this article is a product of the learning orientation I came to adopt for conducting FAR in this team.

4 Results: Learning responses to FAR

How did the collaborative project team respond to FAR? On my arrival, a few weeks after the rest of the team, one of the more forthright members told me that there had been some speculation about the FAR role: would I be an evaluator, a shrink, or perhaps the kind of priest one confesses to? While these three caricatures proved convenient for reminding the team what I was not, they did represent extreme versions of roles that, respectively, find out *about*, reflect *with* or intervene *for*. The team's speculation had been astute. Shortly afterwards, when several members of the team were having lunch together and we fell to talking about my FAR work, one of my colleagues announced with glee, "We are your lab rats!" We were all trying to grasp the relational implications of the

FAR role. As it transpired, being learned *about* was relatively straight forward; being learned *for* and learning *with* FAR was not.

4.1 Being Learned *about* ("Can you switch your recorder on?")

Learning about the team constituted the mainstay of my FAR work. Throughout the project, most members of the team were unwaveringly open about being researched. This seemed to be a matter of principle; as researchers they believed in the exercise of curiosity, even if they were the 'objects' of my curiosity. When I was preparing to present FAR results at conferences, I asked the project management team, comprising three principal investigators, whether there were any limitations to what they were comfortable for me to share on a public platform. Their response was, "… you can present the project in whatever way you think most useful, including the good, the bad and the ugly." For some people in the project, this position of openness blossomed into enthusiasm. For example, on more than one occasion, a conversation with a colleague unexpectedly started to produce rich FAR insights about collaborative experiences and the colleague requested that I turn on my voice recorder so that these insights could be captured.

4.2 Learning *with* FAR ("Will you make us stare into the void?")

As a collective, the team's response to learning *with* was largely characterized by ambivalence and reticence. For example, one of the FAR presentations to the team took the form of a narrative of the project to date, told from my perspective. When I invited my colleagues to enrich this narrative by developing a next iteration, told from multiple perspectives, several members of the team expressed gratitude that I had faithfully mirrored back their experiences – both the highs and the lows – and politely declined the invitation. The main reason given was lack of time.

Indeed, expecting members of the team to engage in collective learning *with* exercises proved unrealistic. They were already intensely engaged in their own research and managing a high degree of complexity in their collaborative work. More than lack of time, however, reflecting collectively on the findings could open up unresolved epistemic and social difficulties, requiring a degree of emotional attention for which researchers were not necessarily prepared. For example, an opportunity to look back on our work together was turned down on the basis that it would be preferable to celebrate what we had achieved "…rather than stare at the void between expectations and reality." Reflection might lead to exploring not only the sense of accomplishment, but also, inevitably, some

feelings of disappointment. I came to understand that this would be difficult to do collectively.

However, there were indications of growing reflexive awareness in the team. During a meeting, a colleague leaned over and said quietly, “This must be gold for you.” Amusing or tense team dynamics were sometimes explicitly referred to as “FAR moments”. This suggested that my colleagues were starting to observe themselves more closely due to my presence. I also became aware of some colleagues watching me closely to gauge my reaction to certain experiences. The observer was being observed. While moving along the lunch queue in the university canteen one day, a project team member told me she had been watching me during a team meeting in which I had been a participant observer that morning. She was sure she had noticed me suppressing a smile during one of the exchanges. Then we talked about that exchange and how we had both experienced it. I found such feedback useful to me, and indicative of a gradual increase in receptivity to learning *with*. But these were modest developments. While the *presence* of a formative accompanying researcher had raised self-awareness in the team, this was not yet tantamount to a shared reflexive research practice. Instead, the impression was sometimes given that team reflexivity had been outsourced to FAR.

The difference between team members’ readiness to engage in learning *with* FAR collectively or as individuals was instructive. Several individuals sought me out regularly to reflect on their experiences in the collaboration. In turn, I approached individuals in the team – especially those in leadership positions – to ascertain their interest in jointly reflecting on the project. Many of my most fruitful conversations took place with individual members of the team as we tramped through the woodland outside the campus and talked about what I was experiencing in my FAR role and what they were experiencing in their leadership role and tried to make sense of this together.

4.3 Being Learned *for* (“Please don’t be helpful”)

The project proposal indicated that FAR would “induce a learning process among the researchers.” (Project description, 2014, p. 19). The word ‘induce’ brought to my mind childbirth interventions when the natural labouring process is slow to start. However, the expectation that I would intervene to learn *for* the team was downplayed early on when a senior colleague advised me to focus mainly on my research rather than try to be “helpful” to the team. To an extent, this was intended to protect me from getting distracted from my own research, given tight timeframes of the research project, and from getting entangled in institutional issues that were beyond my authority to address. But it was one of several signals of resistance to instigating learning interventions from

the FAR role and so I waited to be asked. On the other hand, some members of the team perceived a need for FAR help to support team-wide learning, most noticeably post-doctoral researchers with international work experience outside academia. This had exposed them to different ways of working in teams, and to more proactive approaches to engaging with whole team dynamics of collaboration.

As the project approached its final year, I was invited to contribute to the integration work of the team when one of the principal investigators responsible for integration went on maternity leave. This involved direct intervention, to help the team pull together themes and insights arising from our individual research. In my integration work of helping to convene, design and facilitate team retreats and colloquiums, I experienced a range of responses to these attempts to learn *for*. The participation of some senior team members waned considerably during this time, many of whom were under significant pressure to deliver in other aspects of their academic work. However, there were high levels of responsiveness from others in the team, and willingness to try unfamiliar dialogue-based approaches to integration. This had the advantage of giving more voice and responsibility to junior researchers closest to the research, and the disadvantage that these integration efforts lacked the knowledge and insight of more senior researchers.

While contributing to the integration work, I was aware of some confusion among my colleagues about when I was researching the team and when I was helping the team. Sometimes I shared their confusion. If the integration work was not going as smoothly as intended, did that constitute a FAR finding to be curious about, or a problem I should solve? If the latter, I did not have the institutional authority to make a deeper intervention, such as insisting on active involvement of all team members in the integration work.

5 Discussion

Here I discuss the findings from my own perspective, augmented by insights shared by several individual members of the project team. I focus especially on the implications of extending into the relatively unfamiliar research terrain of learning *with* and *for* a team. I expect that readers with collaborative research experience will identify other aspects from the narrative in section 4 and hope that these prompt further reflection on learning on aspects that I do not pick up for discussion in this article.

5.1 Reflections on learning *about* the team

It was a privilege to be given unfettered access to the team's daily experiences of collaboration. I was able to learn a considerable amount about collaboration as a result. But a limitation of only learning about a team is the risk of "ventriloquism" – i.e. of "speaking for the lives and realities of 'our' subjects without them being actively present in that process." (Wadsworth, 2006: 323). Moreover my single-perspective analysis of these experiences lacked the texture and nuance that my colleagues' perspectives could provide. Thus the possibility to learn *with* and *for* the team opens up avenues, away from conventional approaches to research, for deeper understanding and learning by both the formative accompanying researchers and the team itself. I was disappointed not to pursue those avenues more extensively.

In the current move towards more transdisciplinary approaches to research, there is a productive parallel to be made here. Sustainability research has embraced the imperative to conduct research *with* people historically cast as research 'objects' (e.g., Lang et al., 2012). While the rationale for producing knowledge in this way cannot be faulted, sustainability researchers can be unrealistic about the feasibility of full participation by their extra-scientific partners under prevailing research conditions (Felt et al., 2012). FAR provided a lived experience of the underlying ambivalence, reticence and resistance that can accompany the repositioning of 'research object' to knowledge co-producer. What does this mean for research into research that can learn *with* and *for* a collaborative team?

5.2 Reflections on learning *with* the team

Learning *with* requires engagement by members of the research team itself. This demands time and effort, as well as emotional investment, which is beyond what many researchers anticipate in a university environment (Callard and Fitzgerald, 2015; Griffin et al., 2013; Lotrecchiano et al., 2016). The FAR role was new for everyone and the learning *with* dimension was a foreign proposition for most. In my previous work in several multi-stakeholder social change collaborations outside of the university setting, I have encountered more readiness for this kind of engagement.

However, there may have been wisdom in the team's reluctance to engage in collective reflection exercises. Conditions for exploring difficult issues together were not in place. Not only does a FAR-type researcher have to be skilled and trustworthy, but the situation has to be experienced to be safe enough and the team has to be skilled in reflection and dialogue practices (e.g., Wadsworth, 2006; Wiek et al., 2016). While there were robust

discussions about individual epistemological or methodological orientations, this team tended to avoid addressing interpersonal differences arising from the experience of collaborating. Cheruvelil et al. (2014: 35) argue that high performing research teams treat conflict as "normal and necessary". While I agree with this in principle, it was counterproductive to push members of the team beyond their comfort zones when conditions were not conducive.

However, learning *with* can also be done individually and reflecting on collaborative experiences with interested individuals was more productive than I had anticipated. This became a valuable FAR strategy that had reciprocal benefit to me as a researcher and to members of the team who wanted to contemplate fruitful or puzzling aspects of their experience. Informally, I have had feedback that these one to one reflections have been very beneficial and equipped individuals with skills and insights for their future collaborative work. I also found that that collective reflection was a viable option with small groups of receptive team members. This helped to temper my frustration about the larger team's ambivalence to learning *with* FAR.

5.3 Reflections on learning *for* the team

Intervention is a double-edged opportunity, to be handled with care. Well-intended interventions can have unintended consequences related to shifts in relational and positional dynamics between a researcher and the team she or he is learning *for*. Authority, power and responsibility for outcomes are in flux on both sides of the research relationship. When a researcher into research is co-opted into an intervention role, as I willingly was, it is useful to recall that 'to be co-opted' has a double meaning: to be given authority to play a particular role, or to become complicit and lose perspective (Hackett and Rhoten, 2011). I knew this in theory, but in practice I sometimes traded in my researcher curiosity about whether the team could integrate its work satisfactorily, for trying to ensure that it would.

Following on from justified ambivalence to learning *with*, there may be good reason to be wary of researcher interventions conducted in the name of learning *for* (Nickelsen, 2009). Collaborative teams might experience a well-intended intervention as unhelpful interference; the Latin etymology of 'intervention' indicates a strong undertone of 'coming between', or 'interrupting'. This can result in mixed messages from the team about authorizing an intervention. If a team formally invites, or consents to, an invention on their collective behalf, their hesitation may reveal itself in subtle ways and a researcher may find his or her efforts to learn *for* blocked.

Indeed, a measure of wariness is warranted on both sides of the research relationship. Balmer et al. (2015, p. 10) warn STS researchers about taking on traditional "wife" roles in relation to a team, which includes doing emotional labour on its behalf, or absorbing emotional overspill from interpersonal dynamics between collaborators. I found that assuming a degree of responsibility for the content, processes or emotional wellbeing of the research team happened in a gradual and stealthy way over the three years. Feeling responsible enriched my work of learning *about* and *with* the team, because I gained a more intimate sense of the internal tensions, but complicated my work because I had to try to understand my own contributions and reactions to those tensions. I was "…in the action… finite and dirty, not transcendent and clean" (Haraway, 1996: 439). Methodological literature on participant observation and action research was very useful in this respect; we complemented this with a FAR methodology of balancing acts, practices and principles (Freeth & Vilsmaier, in review).

6 Recommendations

When creating a research into research role in an interdisciplinary team, it is fruitful to first identify the learning appetite and needs of the sustainability project and hence what kind of learning the researcher should conduct. Will the researcher study the team and leave with the insights gleaned (learning about)? Will she or he share their data for collectively making sense of it and developing insights together (learning with)? And will the researcher design and implement interventions on the basis of these insights (learning for)? Those responsible for initiating a collaborative research project may define research into research based on just one of these options, or seek synergy between all three. The following recommendations identify conditions for taking advantage of research into research for the benefit of the collaboration.

If the intention is for the researcher to learn *about*, then enabling conditions include:

- Funding for the researcher to stay with the team for the full duration, to learn about the collaborative disciplinary dynamics over a full project cycle;
- Expectations (from policy downwards) that this research will advance ethical and responsible research collaborations, without falling into the trap of shallow accountability; and
- A culture of openness within a collaborative research team to being observed and learned about.

If the researcher is expected to learn *with*, then enabling conditions include:

- Funding for the researcher to start before the project, to weave a learning orientation into the design of the project, and to stay afterward, to complete the sense-making and documenting process;
- Arrangements, formal and informal, that ensure active engagement between project leaders and the researcher so that collaborative challenges are available for discussion and project decisions are enriched by research into research;
- Periodic full-team reflections, set into the project proposal as both a milestone and deliverable, to take stock of collaboration processes and outcomes; and
- A team environment conducive to collective reflection so that reflexive learning activities complement the team's research work rather than competing for time and attention. Furthermore, a conducive environment combines ease and safety (to address sources of ambivalence or resistance) with some disquiet about unrealized potential. This combination fosters manageable risk-taking for deeper understanding and learning (Freeth & Caniglia, in press).

In some cases, learning *about* and *with* are not enough and learning interventions are valuable. These can include, for example, training and facilitation interventions, as well as research integration and synthesis.

If the researcher is expected to learn *for*, then enabling conditions include:

- Funding for the researcher to stay after the project has ended, to complete and document the outcomes of their intervention;
- Clear authorization to conduct agreed interventions. This includes both institutional support (for example to run accredited courses that build confidence and skills for collaboration) as well as clear communication within the team about where the researcher's responsibility for intervening on the team's behalf begins and ends; and
- Additional supervision from someone external to the team, who can help the researcher to reflect on, and balance, their responsibility for research with their responsibility for intervention.

It is evident that addressing the kind of collaboration difficulties that arise at the level of a research team also requires investment in learning by role players beyond the team.

While project planners and leaders are primarily responsible for creating the conditions for learning, they need the backing of their institutions and the funders and policy makers that resource, encourage and guide such collaborations. The recommendations above complement other recommendations arising from a growing body of research, including evidence-based reports commissioned by policy makers and research councils, for creating enabling structural and educational conditions to advance interdisciplinary collaboration (e.g., Brown et al., 2015; Fitzgerald and Callard, 2014; Gleed and Marchant, 2016; Hampton and Parker, 2011).

7 Conclusion

Our collaborative research project is in its final stages and the next step of the FAR work will systematically inquire into the research team's account of the FAR role. The extent to which FAR was 'successful' in learning about, with and for the team is yet to be determined.

Since embarking on FAR in 2015, we have noticed interest within our own university and amongst colleagues elsewhere in creating such a role in their own collaborative research teams. Regardless of the title given to this role, the idea that a member of an interdisciplinary team conducts research in relation to the team itself, and that this enables learning, has considerable appeal. In some cases, this appeal relates to methodological innovation on its own terms, but there is also an expectation that FAR can be a means to another end, i.e. to advance the practice of collaborative interdisciplinary research. A key learning has been that this is really only feasible with active engagement from the team itself. A formative accompanying researcher can do little to advance collaborations by reflecting and learning on behalf of the team. This may promote some second-hand learning, but it is unlikely to be internalized by team members for addressing current and future collaboration challenges.

Collective engagement in learning to collaborate while collaborating is counter-cultural in many academic settings. If a full team is to take advantage of the presence of a FAR researcher, certain conditions can be put in place to create an environment that supports learning to collaborate while collaborating. The recommendations contained in this article make a start in identifying the creation of such conditions. An advantage of the project-based nature of most collaborative research in the field of sustainability is that those who design and implement projects have opportunity to establish these conditions while developing conceptual and funding proposals.

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APPENDIX 1

INSIDE-OUT SUSTAINABILITY: THE NEGLECT OF INNER WORLDS

Christopher D. Ives, Rebecca Freeth & Joern Fischer

ABSTRACT

In the context of continuing ecosystem degradation and deepening socio-economic inequality, sustainability scientists must question the adequacy of current scholarship and practice. We argue that pre-occupation with external phenomena and collective social structures has led to the neglect of people's 'inner worlds' – their emotions, thoughts, identities and beliefs. These lie at the heart of actions for sustainability, and have powerful transformative capacity for system change. The condition of people's inner worlds ought to also be considered a dimension of sustainability itself. Compassion, empathy and generosity, for example, are personal characteristics that mark individual expressions of sustainability. Sustainability science must take inner life more seriously by considering how language shapes and is shaped by paradigms about the world, prioritising enquiry into how spirituality, contemplation and sustainability transformation relate, and encouraging scholars and practitioners to intentionally cultivate their inner worlds to strengthen inner resources necessary for addressing sustainability challenges.

1 Introduction

"I used to think the top environmental problems were biodiversity loss, ecosystem collapse and climate change. I thought with 30 years of good science we could address those problems. But I was wrong. The top environmental problems are selfishness, greed and apathy… And to deal with these we need a spiritual and cultural transformation - and we scientists don't know how to do that."

- James Gustave Speth

Sustainability science has come a long way in the last 20 years. Since Kates et al. (2001) published their pioneering essay, sustainability science has burgeoned as an integrative and applied discipline. Bringing together economics, social science, ecology and technology studies (Komiyama and Takeuchi 2006), the quest began to solve the most pressing practical and ethical challenges facing the planet and to address them via appropriate policies. Indeed, sustainability has moved from a buzzword to a mainstay concept in nearly all areas of society. However, despite the prominence of sustainability as a concept, planetary trajectories remain deeply unsustainable (e.g. WWF 2016).

Now that sustainability science is well established as a field of scholarship, it is timely to consider how it has progressed and where the field needs to go in the future. This article contends that despite substantial analytical advancement, sustainability scholarship has not catalysed the necessary change. The vast majority of sustainability science has focused on the external world of ecosystems, economic markets, social structures and governance dynamics. In doing so, a critical second dimension of reality has been neglected: the inner lives of individuals. We argue here that our inner worlds, such as our emotions, thoughts, identities and beliefs, lie at the root of sustainability challenges and are fundamental to the solutions to some of the world's greatest challenges. Yet, apart from a few scattered examples (e.g. Wolf 2012; Horlings and Padt 2013), the inner life has evaded explicit analysis within mainstream sustainability science because it cannot be understood via traditional scientific tools, approaches and terminologies.

Some fields of knowledge have long recognised the importance of inner dimensions of human experience. Aristotle's concept of Phronesis (or 'practical wisdom') is an important concept in classical philosophy. Practical wisdom has an inner source. One acquires an intuitive kind of knowledge, borne of experience, that enables action in uncertain or unprecedented situations (Harding 2009). Another foundational philosophical theory is David Hume's theory of motivation (Hume 1975). Hume asserted

that the motivation to perform some action is dependent on both an inner belief that the action is right, and the desire to perform it.

However, only more recently have environmental and sustainability scholars started to attend to inner worlds. A topic that has received considerable attention is the notion of value shift as integral to combating the environmental crisis. Martin et al. (2016, 6105) suggested that “we need fundamental shifts in values that ensure transition from a growth-centered society to one acknowledging biophysical limits and centered on human well-being and biodiversity conservation”. This is a call for change progressing from the inside out (see O’Brien 2013). Value shift also is a current topic of debate in conservation science (Manfredo et al., 2017; Ives & Fischer, 2017). However, most of this discourse remains focused on interior change at the collective group (or societal) scale – that is, communities, and societies as a whole hold certain collective values which may or may not be conducive to sustainability. To date, scholars seem to have neglected the importance of individual inner lives, including their own. Yet, the inner lives of individuals have been (perhaps unsurprisingly) highlighted by those outside academic circles, especially in spiritual arenas. For example, Pope Francis in his Church Encyclical Laudato Si (On care for our common home) suggests "the ecological crisis is also a summons to profound interior conversion… I am interested in how such a spirituality can motivate us to a more passionate concern for the protection of our world“ (Pope Francis 2015). Similarly, in “Ethics for the New Millennium”, the Dalai Lama (1999) argued that greater attention to our inner worlds would both lead to greater individual happiness, as well as provide a sound foundation for a more ethical and sustainable global community.

Against this background, our aims for this article are twofold: to highlight the neglect of our inner worlds in sustainability scholarship and practice, and to stimulate discussion of how engaging with our inner worlds may help effect change towards sustainability. We seek to speak as ‘mainstream’ sustainability scientists to other colleagues in our field, hoping to encourage members of our own field to begin to engage more deeply with the notion of inner worlds. In due course, this will necessarily entail bridging gaps to existing work from other disciplines, such as extensive scholarship on individuals’ inner worlds from branches of philosophy and psychology. Here, we do not try to complete this journey, but rather lay down arguments for why it will be worthwhile to start taking steps in that direction. To begin, we explore four realms of inquiry and how they have been emphasised in sustainability science over time.

2 Viewing sustainability science through four realms of enquiry

Sustainability science has emerged as an integrative arena that brings together many disciplines with a focus on understanding the connections between human and natural systems so as to generate solutions for pressing planetary challenges. Sustainability science has been described as 'use-inspired basic research', highlighting its dual role of generating fundamental understandings of the world and providing practical solutions (Clark 2007). Yet, some domains of reality have been neglected in sustainability science. To understand this more fully, we distinguish between two dimensions of reality: an internally versus externally experienced dimension; and an individually versus collectively experienced dimension. Following Wilber (2000), we recognise that combining these two dimensions yields four domains of human experience, or four ways of generating knowledge about the world. These four dimensions can be labelled as follows: (1) 'it' - knowledge of exterior and individual phenomena, (2) 'they' - knowledge of exterior and collective phenomena and their interactions, (3) 'we' - knowledge of internal and collective phenomena and their interactions, and (4) 'I' - knowledge of internal and individual phenomena and experiences (Esbjörn-Hargens 2010). We show below how sustainability science relates to each of these four dimensions, and argue that the fourth dimension – 'I' – has been largely neglected to date. A summary of the four realms of enquiry is outlined in Table 12.

2.1 It - exterior individual

The 'it' domain might be understood as empirical enquiry into the outside world. It focuses on understanding external phenomena, often in a quantitative way, and adopts an objectivist epistemology, which ensures the researcher is kept at a distance from the subject. Questions that are answered through this form of enquiry might relate to the chemical composition of a substance or its behaviour in different settings. This type of knowledge is sometimes connoted with the 'pure sciences', and has important contributions to make to sustainability. The 'it' quadrant is closely connected with 'environmental science', a precursive discipline to sustainability science. Topics of interest may include the amount of carbon stored in soil or the mineralogy of bedrock underlying a river basin.

2.2 They - exterior collective

This dimension is closely related to systems thinking. Sustainability science was established as a field that seeks to "understand the fundamental character of interactions

between nature and society" (Kates et al. 2001, 641). In this way, a systems perspective has been central to the development of the field, focusing on relationships among system elements. These include the biotic and abiotic elements of ecosystems and the influence of social structures such as institutions and policies on these elements. Questions in this domain may include 'what is the effect of the use of agricultural pesticides on river ecosystems?' or 'how do fishing quotas lead to recovery of fish populations?'. In this way, the 'exterior-collective' domain has been the primary focus of sustainability science to date. Major advances in sustainability science have been possible through employing systems thinking (Fischer et al. 2015).

Realm of Enquiry	**Mode of Enquiry**	**Focus of Enquiry**	**Insights for Sustainability Practice**	**Examples of Sustainability Questions**
It	Empirical, positivist, reductionist	Biophysical	Composition of the exterior world (descriptive)	How much carbon is captured in permafrost?
They	Systems thinking, e.g. stocks, flows and feedbacks	Natural, social, or social-ecological systems, e.g. institutions and ecosystems	Dynamics of the exterior world, including change dynamics	What is the effect of climate change on permafrost, and which feedbacks result from permafrost melting?
We	Recognition of plurality, both qualitative and quantitative	Cultures	Recognising plurality in values to effect social and cultural change; increasing public participation	What are the implications of a post-truth culture in trying to address climate change?
I	Personal reflection and introspection	Personal experience and beliefs	Beliefs about what constitutes a 'good life'; Deep assumptions about what matters; Mental wellbeing; Psychological maturity; Spiritual outlook	What is the inner basis for taking action to influence the exterior world? How can individuals tap into inner sources – e.g. spiritual, emotional, value-related – to resource and sustain creative (scientific and other) endeavour in the face of climate change in a post-truth culture?

Table 12: Four dimensions of how humans understand and experience reality

(c.f. Esbjörn-Hargens 2010) and their actual or potential contribution to sustainability science.

2.3 We - interior collective

The “we” dimension describes collectively experienced, internal phenomena, such as social values. In recent years, sustainability scholars have begun to emphasise the importance of intangible and internal dimensions of human experience. Miller et al. (2014) for example, argued for the need to move beyond simply the analysis of sustainability problems to also consider social values. They state that “inquiries into values are largely absent from the mainstream sustainability science agenda. Yet, at its core, sustainability is a fundamentally ethical concept raising questions regarding the value of nature, responsibilities to future generations and social justice” (p. 241). This recognition of values has been framed in the context of collective groups, and has been tied closely with discourses of reflexive governance and participatory decision-making (Reed et al. 2010; Smith and Stirling 2017). The central argument has been that robust decisions for sustainability in a ‘post-normal’ world (Funtowicz and Ravetz 1994) require the careful integration of scientific knowledge with diverse and plural stakeholder values and perspectives (Colloff et al. 2017). The assessment of social values has therefore become a rapidly growing field of enquiry in sustainability and conservation (Ives and Kendal 2014; Kenter et al. 2015; Tadaki et al. 2017). Indeed, as Miller et al. (2014, 241) state “As soon as values become a core part of the sustainability research agenda, then the need for participatory approaches follows, since decisions can no longer be based solely on technical or scientific criteria (the domain of expert knowledge) alone”. Questions relevant to this domain include ‘what visions for sustainability do different stakeholders have?’ and ‘what sets of values are embedded in policy frameworks?’. Navigating a plurality of values, in turn, has major benefits for uncovering socially robust trajectories towards environmental sustainability (Kenter et al. 2015; Scholz and Steiner 2015).

2.4 I - interior individual

Finally, the “I” dimension relates to the inner worlds of individual people. Unlike the previous three domains, the interior-individual domain has been almost entirely neglected in sustainability science. The inner landscape of both sustainability scholars and members of communities that researchers investigate has been largely overlooked or seen as inaccessible. And yet, we argue that there is a fundamental relationship between our inner lives and the kind of sustainable future that we aspire to create. Science typically removes the subject of research from the investigator, but there is a need for greater integration. We concur with Wamsler et al. (2017) who call for “more sustainability research that acknowledges positive emotional connections, spirituality, and mindfulness in particular, recognizing that the micro and macro are mirrored and

interrelated." The interior lives of individuals might be understood as a 'deep leverage point' (Meadows 1999; Abson et al. 2017; Fischer and Riechers 2019) for change, because the goals, values, worldviews and emotions of people are the places from which the motivations and methods for pursuing sustainability originate and can be maintained. Key questions that this domain asks are 'who?' and 'why?'. While other domains of investigation focus on the 'what' or 'how' of sustainability, this domain seeks to understand more deeply 'who' is pursuing sustainability, and 'why' an individual lives the way she does. Understanding our inner lives is central to this goal and a failure to look inwardly might compromise our ability to work effectively for ('good') change. Despite its lack of attention to inner worlds to date, given its position as an integrative arena, sustainability science may be ideally positioned to function as a boundary space to more fully capture these phenomena in the context of other dimensions of the world.

In talking about individuals' inner worlds, we acknowledge that terminology is difficult and often ambiguous. We consider inner worlds to encapsulate entities of values, thoughts, emotions, identities, beliefs and worldviews, amongst others. As such, the term is broad and inclusive, so as to invite exchange of ideas and insights from across academic disciplines. We distinguish inner worlds from phenomena that exist in the 'it', 'they' and 'we' dimensions, which have been the primary focus of sustainability science to date. We recognise that the four domains we outline are a simplified abstraction for the purpose of aiding analysis: often it is in the connections between different domains that human experience of the world is understood. For example, many religious traditions engage interior dimensions via physical, embodied expressions of spirituality in community with other people. Indeed, Buber (1958) famously argued that human experience is summed up in interactions between individuals and objects (I-it relationships) and individuals and other people or the divine (I-thou relationships). Thus, while we discuss the four dimensions discretely, we consider it important to explore relations among these dimensions in the future.

3 Inner worlds as a realm of transformation

Our inner worlds underpin much of how systems function, yet are commonly 'beneath the surface'. One useful image to communicate this is by drawing on the analogy of an iceberg (Figure 11). According to systems thinking, the deepest and most influential levels of a system are the underlying 'mental models': "the filters through which we interpret our experiences, evaluate plans and choose among possible courses of action" (Nguyen and Bosch 2013: 109). These are invisible but inform the questions we deem appropriate to ask, and underpin the structures, patterns and ultimately events that are observed and measured by scientific methods. The capacity for individuals to suspend assumptions,

critique their mental models and potentially adopt new paradigms thus is one of the most powerful ways to dramatically influence sustainability outcomes (Meadows et al. 1999).

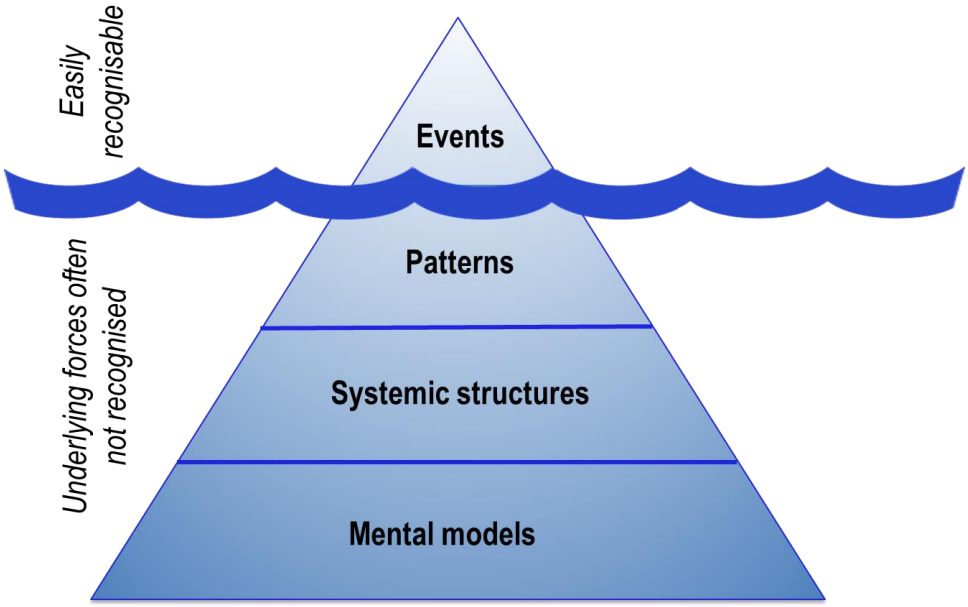

Figure 11: Four dimensions underpinning system function (adapted from WWF 2016; also see Nguyen and Bosch 2013).

We suggest that the sustainability crisis is in large part an emergent property of the state of our inner worlds. If we consider only external solutions to 'out there' problems (such as biodiversity loss, climate change, resource exploitation), we will fail to identify some of the most powerful and effective solutions that begin 'in here'. It might be said that the scale of the sustainability crisis extends all the way from planetary systems to the heart and soul of every human being. In this way, we consider the inner life as both an underexplored means to change, and an end in itself. In short, since our inner lives underpin external change, we argue that change in the world must occur (in part) from the inside-out. Yet change must also occur from the outside-in: our inner lives must be shaped by the reality of the social and environmental injustices that are occurring in the world today. In this way, taking our inner lives seriously does not mean separating ourselves from external reality as a form of escapism. Rather, we argue for inner lives that reflect more closely the challenges of sustainability that are before us.

3.1 The inner life as a means to sustainability outcomes

There are signs of an opening up of scientific horizons in sustainability science that could accommodate such an appreciation of inner lives. For example, effective action for

sustainability is increasingly understood to require not only systems knowledge (technical knowledge of how systems function) but also normative knowledge (how systems ought to be), and transformative knowledge (how to change systems to more desirable states) (ProClim—Forum for Climate and Global Change 1997; Abson et al. 2014). The call for transformative science is premised on a commitment to not only study processes of transformation but to activate them, which necessarily involves shifts in the mindsets of many individual stakeholders, including sustainability scientists themselves (Schneidewind et al. 2016). The strongest step in this direction thus far is in sustainability science education and teaching (Caniglia et al. 2016; Wiek et al. 2016). The Aristotlean concept of phronesis (practical wisdom) has also been recognised as essential for sustainability transformations (Fazey et al. 2018). We support these recent efforts to expand thinking in sustainability science and suggest that a focus on 'inner worlds' could help to create coherence in this emerging area of thought.

How can our inner lives influence sustainability? One vital area is through the motivational resources that exist in our inner lives. This includes deep awareness, building of empathy, and willingness to transcend paradigms. Awareness of our deepest motivations and experiences is perhaps the most fundamental (and grossly neglected) aspect of our inner worlds. Practices of individual reflection reveal awareness of society's values and goals, our own values and goals, and differences between the two. Reflection can also help build empathy and compassion towards others by seeing matters from others' points of view. Contemplation can even enable an expansion of empathy to include people from different cultures and locations, and non-human subjects (wildlife, ecosystems), which has been found to relate to pro-environmental behaviour (Berenguer 2003). This 'shifting perspectives' is a fundamental skill in enabling personal paradigms and mental models to be transcended. It is the malleability of personal paradigms that is the most powerful tool for transformative change (Meadows 1999; O'Brien 2018).

Inner life, with its values, goals and (often subconscious) desires, can be understood as the deepest driver of behaviour and behavioural change. Because sustainability ultimately requires behaviour shift (Schultz 2011), revealing, understanding (and potentially influencing) inner life is critical for developing strategies for change. Empathy cultivated via contemplation can be translated into action (Ericson et al. 2014). Paying attention to the inner life can 'tap into' something bigger than oneself. Such 'transcendent' motivation is common to all religious traditions, and has sustained action for profound social change throughout history. Nevertheless, while the inner life is a deep driver of behaviour, it is unlikely to be sufficient to generate the profound systemic change necessary for addressing global sustainability challenges in isolation. Any exploration of inner worlds within sustainability science must be done in conjunction with analysis of institutional structures, social context and politics (see O'Brien 2018).

3.2 A healthy and compassionate inner life as a sustainability goal

Not only are our inner lives fundamental to the pursuit of social and environmental well-being, we suggest that the state of our inner lives ought also to be regarded as something worthwhile in its own right. In relation to the image of the iceberg, sustainability is greater than simply the events that occur (such as the use of renewable energy, or the provision of adequate housing). It necessarily includes the systems and structures that enable sustainability to be realised. A society free from violence thus cannot be called 'sustainable' if 'peace' is maintained through an oppressive dictatorship. In this way, sustainable actions and outcomes are not truly sustainable if motivated by greed or inner discord. At present, many sustainability strategies do not challenge the underlying values that contribute to it, but seek to work with these values (Manfredo et al. 2017). Tax incentives for 'green' products (e.g. electric vehicles) implicitly appeal to greed and materialism in order to shift behaviours. Similarly, sustainability scholars and activists can be driven by insecurity, fear or hubris just as much as other professionals. What if we extended to our own lives the aspiration of wellbeing and flourishing that we strive for in our sustainability work? Exploring inner lives, and working towards sustainability from the inside out, may reveal immaterial sources of lasting contentment and well-being, with positive flow-on effects for the world at large.

4 How could inner life be approached in sustainability science?

Increasing recognition of the inner life in sustainability science is likely to be a long process. This article does not presume to provide a simple blueprint for how to address the neglect of the inner life. Yet, we offer below some starting points to a new pathway, which we hope will open conversation among sustainability scholars and practitioners. We consider that the concept of 'leverage points' for sustainability transformation (Abson et al. 2017; Fischer and Riechers 2019) is a useful framework by which this can be explored. According to Meadows (1999), complex systems possess different 'leverage points' whereby interventions can affect a certain amount of change. Shallow leverage points focus on existing system parameters. They are easily acted upon but unlikely to bring about transformative change. In contrast, deep leverage points tackle underlying worldviews, paradigms and values – they are more difficult to work with, but have much stronger transformative potential. We argue that a focus on the inner life has major potential to function as a domain for deep leverage for change. To operationalise this, we therefore call for (i) an expansion of the language used in framing sustainability, (ii) greater consideration of the inner life in sustainability research, and (iii) enhanced awareness and cultivation of the inner life in practice.

4.1 Framing and language

The language used to articulate sustainability concepts and problems often betrays highly normative perspectives on the framing of sustainability. Lakoff & Johnson (1980) demonstrate that the language we use gives us clues to deep and collectively-held conceptual frameworks (and thus to the paradigms that shape them). We suspect that language contributes to a cycle, either virtuous or vicious: language expresses paradigms, and reinforces them. A change of language, in turn, has potential to challenge deeply held beliefs, and potentially shift them. Indeed, language might be considered a 'deep leverage point', acting to influence system paradigms. For instance, the term "sustainability science" implies a rational approach to the pursuit of maintenance. In contrast, other terms might connect with a deeper desire and inspire us to seek and create the futures we want. Rabinow (2011: 217) refers to a "flourishing" existence, supported by a science of "care"-ful "practices, relationships and experiences". Stengers (1997: 113) writes about (re)awakening a "jouissance" in science, which has potential to bridge the gap between the "intensity" of scientific discovery, and the "sterilizing" language often used to express it. Wahl (2016) also promotes the concept of "regenerative cultures" over sustainability. Even use of the term "the environment" has recently been challenged within public discourse (Monbiot 2017).

Given the importance of language, we call for a greater exploration and expansion of terminology in sustainability that engages both the head and the heart. The term we introduced in this article – inner worlds – is deliberately broad and encompasses many dimensions of internal human phenomena; including, as we outlined above, emotions, thoughts, identities and beliefs. While traditional science typically strives for great conceptual precision, seeking to create sharp boundaries between related concepts (e.g. the distinctions between attitudes, beliefs and values in psychology; Rokeach 1968), such precision can at times constrain integrative enquiry and thereby obscure important insights. Scientific language has also not arisen to develop mindfulness and empathy. We offer the term "inner worlds" as a way of holding together multiple dimensions of "human being" that are otherwise neglected in sustainability science. Similarly to the term "resilience", the vagueness of the term "inner worlds" thus could be considered an asset, in accordance with Strunz's (2012) argument that a certain degree of conceptual vagueness fosters creativity and enables integration across different knowledge domains. The term "inner worlds" thus could help to bring together existing insights, and perhaps generate new ones, with tangible benefits for both sustainability research and practice.

4.2 Research

There are a number of potential research questions salient to how our inner worlds connect with sustainability. We explore a few here, recognising that this list is nowhere near exhaustive. The first set of questions refers to how inner lives of individuals relate to individual behaviours towards sustainability. One dimension of the inner life that is particularly pertinent is that of values. While much has been written in social psychology on the relationship between personal values and behaviours (Dietz et al. 2005; Steg and Vlek 2009), the focus in the context of sustainability has been on values as they exist in a certain population or in a collective sense. For example, there is a voluminous literature on the structure and persistence of human values across different cultures and socio-political contexts (e.g. Schwartz 1994; Inglehart et al. 1998). In contrast, there has been little exploration of personal values as preconditions for action in support of transformative change for sustainability (Ives and Fischer 2017). The importance of personal values in the context of organisational leadership is one area where the relationship of personal dimensions to higher level systemic change is directly relevant (e.g. Hemingway and Maclagan 2004). Of course, values are only one facet of the inner life and should not necessarily be separated from other dimensions of inner experience. There is also a need to explore how other conditions of people's 'inner' lives (such as emotional wellbeing, or capacity for reflection) can enable and motivate actions for sustainability. One area of promising research is the relationship between personal character strengths and virtues and sustainable behaviour (Corral-Verdugo et al. 2015).

The second field of research is how inner worlds can be shaped and transformed to align more with sustainability outcomes. The capacity for personal values to be shaped and shifted intentionally is gathering greater interest (see Raymond and Kenter 2016), and there is a need to explore how such value shift might enable sustainability transformation (Ives and Fischer 2017). The fostering of 'virtues' is another growing field of study that relates deeply to sustainability. Traditional western virtues include humility, kindness, patience, diligence, temperance and charity. Individuals who have inner lives characterised by these qualities may, arguably, be positioned to pursue sustainability passionately and persistently. The need to emphasise virtues in education is increasingly recognised, as the inadequacy of knowledge and skills alone in contributing to a healthy and flourishing society is acknowledged (see Arthur et al. 2017). How such virtues might be cultivated within individuals and how they relate to change for sustainability is therefore an arena ripe for further research.

A third arena for further research is how institutions and organisations that relate to the inner life might promote sustainability. This includes religious groups and communities, and their institutionalised practices such as mindfulness, meditation and contemplation.

With 84% of the global population professing some kind of religious faith (Pew Research Centre 2017), religious institutions are ideally positioned to engage with the inner lives of individuals as they relate to sustainability and to promote inner change. There is therefore a need for research into how various spiritual and religious beliefs and practices might motivate or constrain action for sustainability (Hitzhusen and Tucker 2013). While research has shown somewhat complicated relationships between religiosity and pro-environmental behaviour (Gifford and Nilsson 2014), there is undoubtedly a need to engage spirituality with the sustainability crisis, and religious institutions are ideally situated to do this. As Orr (2002) noted "The transition to sustainability will require learning how to recognize and resolve divergent problems, which is to say a higher level of spiritual awareness".

Finally, there is a need for research on how inner worlds relate to existing theories of social change. Many theories have been proposed, investigated and operationalised. These do not need to be superseded by a 'new' theory of change focused on inner worlds, but rather, understanding inner worlds and their relationship to other quadrants (outlined in section 2) opens up a broader perspective from which new questions can emerge. We have already introduced the concept of 'leverage points' as a theory of change grounded in systems thinking (Abson et al 2017). In this context we see inner worlds as sources of leverage as they can connect observation to realisation and action. They enable dynamics in the other quadrants to be seen and their significance felt, including dynamics of power (the interior-collective dimension 'we'), systems of injustice and unsustainability (the exterior-collective quadrant 'they'), and changes in the biophysical world (the exterior-collective quadrant 'it'). Actively incorporating inner worlds into our analyses would mitigate against the risk of divorcing interior and individual catalysts for change from the larger set of contexts deserving of change. Similar conceptual and empirical research should be done to relate inner worlds to other theories of social-ecological change. Below are a few examples. First, psychologically-grounded causal theories of behaviour, such as Ajzen's Theory of Planned Behaviour (Ajzen 1991) and Stern's Value, Belief, Norm Theory (Stern and Dietz 1994) continue to dominate literature on behaviour-change policy. Consideration of inner worlds could inform how deeply held values are formed and shaped over time, and in response to human interaction and various contexts. Second, social practice theory emphasises the importance of routines and behaviours within distinct social contexts (Shove 2010). There is an opportunity to explore how such practices stem from and influence individuals' inner lives. Finally, social innovation theory explores the emergence of new social solutions to problems within various institutions (Moore and Westley 2011). Considering inner worlds could highlight the inner 'preconditions' for innovation and the meanings of these innovations as they emerge.

4.3 Practice

Of equal importance to undertaking research on the inner life and its relevance to sustainability is the fostering of healthy inner lives of sustainability professionals. In essence, there is a need to 'lower the water line' of the iceberg (Figure 11) – to increasingly expose those invisible dimensions (such as mental models and emotions) that influence the external activities and events we pursue. Structural change in academic institutions may be necessary to combat the increasingly competitive and performance-oriented cultures in many universities (Fischer et al. 2012) to help promote inner health and well-being of faculty staff. Further, in the context of a "post-truth" society that is increasingly skeptical or dismissive of scientific evidence, there is a need for sustainability scholars and practitioners to take time to reflect and create space to build the inner resources that will sustain action over the long term. Practices of solitude and silence have long been held as vital to inner health and wellbeing amongst many religious traditions. Mindfulness techniques have been shown to reduce stress and promote mental health (Grossman et al. 2004), and the potential for these to contribute to sustainability has been recognised recently (Wamsler et al. 2017; Wamsler 2018). We are interested in how participation in these practices could help bring together the inner reality of our lives with the kind of world that sustainability scientists aspire to see.

5 Conclusion

The persistent degradation of the biosphere despite growing scientific knowledge suggests that there is a need for sustainability science to take a look at some of the deeper drivers of anthropogenic planetary change. We have argued that sustainability science has neglected an important dimension of human experience – the inner worlds of individuals. These have the potential to fundamentally shape human behaviour and possibly even the functioning of social systems. We call for greater recognition of the inner life in sustainability science and for a new agenda of research and practice that highlights the inner revolution that is needed. With a greater awareness and activation of inner resources for sustainability, we might just locate the transformative capacity to bring about the change necessary for a safe, just and sustainable future for humanity and the planet.

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APPENDIX 2

BURNING TO BE UNDERSTOOD

Rebecca Freeth
Dark Mountain Book: Issue 15 – In the age of fire

South Africa is a place of fire.

Fynbos, a wondrously diverse type of vegetation indigenous to the Western Cape region of South Africa, needs fire to thrive. The roaring heat and fragrant smoke of a fynbos fire trigger seeds to germinate. After a fire, minerals in the ash return to the soil, nourishing fynbos regrowth. Fire, smoke, ash: phoenix. Without regular exposure to fire, fynbos loses its competitive edge against thicket. But when it burns too frequently, fynbos can't establish itself for long enough to mature. It's a delicate life cycle between persisting and perishing.

In the early days of apartheid, state foresters suppressed burning, ignoring research that showed the ecological benefits of fynbos fire. Mace pagoda, a magnificent flowering species previously found in the mountains behind my cottage, was brought to the brink of extinction as a result of fire suppression. Then an accidental fire roared through the area, reactivating underground seed banks that had been dormant for decades. The protea is the most well-known fynbos flower with its bold beauty, but it is the delicate fire lily that pushes through the ruins within days of a fire, appearing scarlet against the blackened ground.

I experience three sources of heat in South Africa. There is the fire within, visible in raised emotional temperatures and desire for change, now. There is the fire outside, the hot drought of recent years, the increasing tempo of fynbos fires. And there is the fire between us, evident in our relationships across race, and producing plenty of heated exchanges. I know something about the fire within. I was born in England and moved to apartheid South Africa in 1980. A seven-year-old with the sensitive skin of one born to the low, grey skies of northern England. The South African sun blistered my skin. The emotional temperature of racial injustice created a slower burn inside. By the age of 15 my response to the racism that defined my experience of school and neighbourhood life had billowed into full-blown rage. I also know something about the fire outside, having

had my cottage engulfed, but not consumed, by a fynbos fire in 2014. But it's the fires between us that create the liveliest sparks for me.

Colonialism and apartheid were predicated on treating black South Africans as less than human. Spatial apartheid meant that black and white South Africans encountered each other rarely, and only under such bizarre and artificial circumstances that any meaningful conversation was unlikely. Racism stymied what little chance there was to understand each other across racial barriers. Racism continues to stymie understanding 25 years after apartheid officially ended. Black South Africans are burning to speak, burning to have their experiences heard, burning to be understood.

A few years ago, I joined a group of South African professionals committed to dialogue. We met regularly over a two-year period. We were all middle class, most of us mid-career. Two thirds of us were white and one third black. We talked, compulsively, about race and racial injustice past and present. We couldn't focus on anything else. Many moments are seared into my memory. Here are three:

Zanele stands up and immediately fills the room with her presence. She's a successful career woman and mother to three children. There's something compelling about Zanele's presence; she strikes me as deeply self-loving. And when she gets angry, words pour from her like lava from a volcano. A red-hot molten river of words. Her poise in those moments is exquisite. The flow of words and her concentrated anger immerse me in her world of being dismissed, denied and derailed at every turn as a black woman in South Africa. She's angry with us as white people and I can't help but get it. I had thought that my activist parents and my hatred of racism had inoculated me. But it hadn't. I was and am implicated in a system of racism that benefits me at the expense of black South Africans.

On another occasion, we're in the midst of a robust conversation when Nomfundo leaps up. Usually a reserved woman in the group, she shouts: "Why can't you white people see how central you are? Right now!" The room goes quiet. There's simply no denying it. I had thought I understood white centrality, and I had thought that as an introvert who tends to stay on the periphery of group dialogues, I was less guilty of it. But Nomfundo has made me re-think. It's not just how much I speak, it's a sense of entitlement to shared space and how my occupation of that space marginalizes and silences black people.

During one of our final meetings, Mandla puts his head in his hands and his shoulders start to heave. It's shocking. This man was born, and indeed trained, to fight. Hard as it can be to face him when he's angry, it's more painful to see him weep. And he doesn't stop. The grief below the anger knows no bounds.

The black people in the group had a tolerance for heat. They could stay with strong expressions of anger, conflict and grief - which is what was needed. We white people wilted.

Nelson Mandela's extraordinary personal capacity for reconciliation with his oppressors and jailers had the effect of letting white people, generally, off the hook. The Truth and Reconciliation Commission (TRC) created an important space in the late 1990s for the telling of stories of violence, torture and murder by the apartheid state. But too few people received a chance to testify and the very limited lifespan of the TRC revealed only a glimpse of the suffering. The average black South African's anger and grief has still not been publicly spoken, heard or understood.

Around the same time, failure to implement prescribed block-burning of fynbos – now largely for economic reasons in a country trying to redistribute resources – resulted in a massive increase in wildfires. I remember that hot summer's day in January 2000 when 120 wildfires broke out in the Western Cape.

The intensity of heat between South Africans is in stark contrast to my present reality as a PhD researcher in Germany. I'm working in an international team of natural and social scientists studying social-ecological sustainability. A group of smart and hardworking people, my colleagues are sincerely committed to social justice and social-ecological wellbeing. But this South African finds the temperature of our collaboration too cool. Where's the fire?

Every now and then, there is a lick of flame. A colleague sends out a group email to the rest of our research team. It contains links to articles about extinction crises precipitated by the death in Kenya of the last male northern white rhino and by the collapse of bird populations in France. The links are prefixed by a scorching one-liner: "I am delighted to share my sources of motivation with you". Reading this line evokes an image of eyes glittering above her keyboard.

Here, there is fire. My scientific colleague is also burning to be understood. But the response from the team is muted and the heat she feels doesn't visibly carry across to the collective.

It's two years into our research collaboration and we have gathered for a team meeting. An unexpectedly tense exchange is followed by a protracted pause. No one makes eye contact. The meeting convener says, "perfect" in a voice that only just escapes through clenched teeth. We understand the meeting to be over. I open my mouth to say something, to name the difficulty, but people are already starting to troop towards the door and I abandon the impulse.

There is potential for heat in this team but it's being suppressed. This isn't a deliberate strategy; Simon Pooley's (2012) characterization of fynbos fire suppression in the old South Africa as a "failure of nerve" is apt for our research team. There is fear of fire. As a result, frustrations remain largely unspoken and therefore not fully heard or understood. Several people have withdrawn their full presence, disappearing into their research with their quiet disappointments. Our collective work is the poorer for it. Harvard leadership scholars Heifetz and Laurie (1997) say that in teams "nothing cooks without some heat."

This isn't surprising. Who wants strong emotion in the workplace, especially in academia? But as Maja Horst (2013) writes, there is academic mileage to be gained from inquiring into the sources of frustration and disappointment in collaborative research experiences.

My research team also operates in a context that insulates it from external sources of heat. Yes, the big picture issues are urgent, but the immediate situation in Northwestern Europe is another kind of comfort zone. Despite the latest predictions of the Intergovernmental Panel on Climate Change (IPCC) and the fact that evidence of social ecological collapse appears in the team's own research, it requires a vivid imagination to project oneself into these scenarios of climate crisis. The team is young, with most members having been born at least 30 years after the end of World War II. There is no memory of how fast a seemingly stable situation can deteriorate into brutality and hunger.

Why is the temperature of this research team cool? Could it be the stereotypical rational coolness attributed to scientists? Or to men? Or to Germans? Maybe these are factors. But my guess is that our privilege helps to keep team temperatures low. Most of us come from backgrounds that inoculated us against economic hardship or social discrimination. All of us have enjoyed the kind of access to education and other opportunities that smoothed our paths to PhD level and beyond in a Western European university.

I think of privilege as a form of centrality. Those of us with relative privilege are accustomed to having our voices heard and our presence welcomed in most social interactions. This produces an often-unconscious sense of entitlement to being taken seriously, to being central. Experiences of being on the margins are less familiar. Of course, given the myriad identities that make each of us who we are, many of us with privilege have also experienced prejudice in our lives. White women or white gay men for example. In fact we may be so strongly identified with experiences of being displaced in the world of white straight able-bodied men that we don't recognise our own mainstream centrality and how it displaces others.

Arnie Mindell was a Jungian analyst in Switzerland when he started to transfer some of his ideas to groups. The Deep Democracy approach to dialogue evolved from here. Deep

Democracy welcomes the fuller expression of our experience, to deepen our understanding of each other and strengthen our relationships, whether personal or professional. This includes the expression of conflict and strong emotion. Mindell talks about this as “sitting in the fire” (1995). Not just walking through fire, but planting one’s posterior among the coals and staying. The implications are that people working for social, or social-ecological, change develop a tolerance for the heat that invariably comes with real change. To be less afraid of immolation, to grow a skin that can withstand intense heat for the sake of deep learning and deep change.

Deep Democracy works especially well where there is a power differential, because it takes seriously encounters between those at the centre and those at the margins. Instead of trying to make conflict or anger go away for the sake of peaceful group relations, Deep Democracy treats the heat as a signal for those with privilege to listen. To toughen up in the face of scorching temperatures. To respond with urgency without re-centering ourselves. To stop dampening the flames with a coolly colonial attitude – whether in the name of ‘civilized’ or ‘scientific’ discourse - that makes other ways of relating illegitimate.

On more than one occasion, I’ve watched a fynbos fire move across the mountain range behind my cottage. At night, it’s a beautiful sight. One moment it looks very far away, a silent image of dancing orange against the dark sky, observed through the safety of my bedroom window. I’ve felt a mixture of sympathy and smugness in relation to people who built grand holiday houses on the mountain slopes. The next moment, the ever-present coastal wind carries sparks to a spot much closer to my cottage and whips them into flame. Suddenly, I’m no longer a complacent spectator on the periphery.

Sometimes fiery exchanges combust unexpectedly at close proximity, and it’s no longer possible to be a bystander, confidently assuming the problem belongs to others. We may be implicated.

Of course, it’s not just black South Africans who possess a hard-earned capacity to sit in the fire. Most people who have experienced profound struggle and silencing have developed this resilience. I found out about this last year at an international Deep Democracy dialogue in Greece and then I had an unexpected lesson about the long haul of cultivating resilience.

We arrive in Greece from 47 different countries to participate in a week of Deep Democracy. Old-fashioned democracy has recently produced President Trump and Brexit, and has allowed Erdogan, Putin and innumerable others to get away with murder. During six intense days together, we seek to remain available to the full spectrum of experiences and opinions related not only to the rise of the political right all over the world, but also to people of colour from all over the world living with legacies of colonialism, women in

Japan struggling to find their public voices, women – and some men – navigating life after sexual assault, people who identify as queer dealing with power dynamics within the queer community. Perhaps most powerful of all, people from different African countries choosing to have a public conversation with each other about the risk of becoming apologists for whiteness, refusing to allow any of the white facilitators on hand to facilitate their conversation.

It is hot.

The deal is that every voice deserves to be heard. Especially the ones we don't want to hear because they carry too much hatred, or pain. These are often the ones we've silenced internally too, especially if, at our most honest, those voices have found a small echo within us. By listening to every perspective, we carve out more spaciousness within ourselves to hold the whole picture, not just the bits we like. By acknowledging the pain that can calcify into hatred, maybe there's a chance for healing the self and acknowledging what has been silenced both internally and externally. Rather than simply seeking to destroy the other. Together, we may come to better - more nuanced and more sustainable - decisions that still represent the majority but are vastly improved by also taking seriously the reservations of various minority perspectives.

I sit, one among 550. Zanele is here too. None of us are passive spectators; we're all caught up in the experiences of being more central or more marginal, of trying to deepen the democracy between us, regardless of the issue. But the introvert in me keeps me firmly attached to my chair, reluctant to participate more actively. On the penultimate day, we agree to talk about an issue we've been skirting: colonialism. When the facilitators request that someone speak from an authentic experience, so that we don't end up in a superficial role-play, I find myself rising from my seat next to Zanele. My great-grandfather was a British missionary to Bengal. On the other side of my family, the men have served in the British army for as long as anyone can remember. This is a history about which I would happily keep quiet. Not today apparently.

I thought I'd developed a pretty high tolerance for heat in South Africa, but I was woefully underprepared. As I embodied my lineage, the heat proved more than I could take and so I did exactly what any cool, rational, order-loving colonizer would do and asked everyone to calm down. Not surprisingly, this polite request had the opposite effect. Fuel to the fire. Whoosh! That experience created a simmering curiosity to know more about my colonial ancestry.

Those of us with privilege have largely been shielded. We haven't had to toughen up. We don't have the inbuilt resilience developed by enduring the daily insults and closed doors that come with inequality and injustice. Even those working in the field of sustainability

research don't necessarily feel the same sense of urgency as those at the frontline of ecological disruption. We can still afford a certain degree of denial that disaster will befall us, a certain level of cool.

So what does it mean to learn to sit in fire? To willingly be exposed to heat in relationship? How will that kind of heat tolerance help us survive other kinds of heat that may be coming? And what can we learn from fynbos? I'm learning to be in the fire often enough to germinate new growth, but not so often that the new growth is lost. Fire can be an addiction; I've worked in groups with pyromaniacs who light little fires all the time.

Soon I will return to South Africa, with my privilege intact, and I'm checking my flammability levels. My skin, once again paled by the long winters of Europe, needs to be both sensitive enough to pick up on subtle signals of disturbance, and fireproof enough to sit in the heat of ongoing and necessary social upheaval in South Africa.

And that's not an exclusively South African task.

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With my thanks to Zanele, whose fine anger was a catalyst for me to listen more closely to anger, and to learn how to breathe my own dragon fire.

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