



# Facet Theory and the Mapping Sentence

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Evolving Philosophy, Use and  
Declarative Applications

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Paul M. W. Hackett

*Second Edition*

palgrave  
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*This book is dedicated to Jessica  
(Gloucester, Massachusetts, September 2020)*

Other books on facet theory and mapping sentences by Paul M.M. Hackett include:

Lustig, K., & Hackett, P. M. W. (2020). *Philosophy of Facet Theory Pocket Guide*. San Francisco: Blurb Publishers.

Lustig, K., & Hackett, P. M. W. (2020). *Mapping Sentence Pocket Guide*. San Francisco: Blurb Publishers.

Hackett, P. M. W. (2020). *Declarative Mapping Sentences in Qualitative Research: Theoretical, Linguistic, and Applied Usages*. London: Routledge (In Press)

Hackett, P. M. W. (2020). *The Complexity of Bird Behaviour: A Facet Theory Approach*. Cham, CH: Springer.

Hackett, P. M. W., & Fisher, Y. (Eds.). (2019). *Advances in Facet Theory Research: Developments in Theory and Application and Competing Approaches*. Lausanne, Switzerland: Frontiers Media SA.

Hackett, P. M. W. (Ed.). (2019). *Conceptual Categories and the Structure of Reality: Theoretical and Empirical Approaches*. Lausanne, Switzerland: Frontiers Media SA.

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# Foreword

*Facet Theory is still only slightly recognized by psychologists and other social sciences. Even when it is accepted, it is only partially understood.*

These words were said by David Canter (1985) more than three decades ago in the foreword to his book *Facet Theory: Approaches to Social Research*. And unfortunately, these words are still accurate today. In the past thirty-five years since Canter published his book, a few hundreds of studies have used Facet Theory for designing research, developing theory, statistical analysis, and explaining complex phenomena. Nevertheless, the distribution of the Facet Theory is limited, and the access to it is still relatively limited.

Facet Theory is an approach used in the social sciences, which combines research design with data analysis. It enables us to identify the components of concepts and constructs and display the inter-relations among them in a graphical presentation. This theory combines empirical concepts and data and finds rules that are difficult to expose in other approaches, especially when it comes to multivariate analysis.

The unique feature of the Facet Theory is that it accompanies the researcher throughout the study. First, in defining the main areas of the concept systematically. These areas are named “facets,” which are the units being studied and investigated. Each facet contains several components, all of which belong to the same classified content area.



A combination of several elements from several different facets creates a *structuple*. This term is unique to Facet Theory (based on the mathematical concept *struct*). The structuples can create variables that are items to be measured in a particular measuring instrument.

The *Mapping Sentence*, which this second edition of Professor Paul Hackett's book will "dive deep" into and explore, is a central feature of Facet Theory. A mapping sentence is a tool that enables us to conceptualize theoretical structures, plan research designs, select the variables for use in a study, and to formulate the hypotheses that we are about to investigate. The mapping sentence maps the elements in a study's observation and the study's population groups to the response range of the studied stimuli. We can find in the mapping sentence several types of facets: content facets, population facets, and range facets. The mapping sentence links the areas defined in the study. The expressions used in the mapping sentence include link words to make the mapping operation of the variables into a coherent, readable sentence and therefore developing the bringing mapping operation into a "mapping sentence". In a quantitative study based on a mapping sentence, we conduct data analysis by calculating a correlation matrix (monotonicity coefficients), and correlations are "translated" into distances on a geometric space (map). The map is prepared using a technique called "Smallestspace Analysis" (SSA) (also called "Similarity Structure Analysis"). This is a non-metric system which allows for a geometric display of the correlation matrix based on the degree of correlation between the observed variables.

One of the reasons for the lack of use of Facet Theory among the academic community, is probably the need for a different thinking method than the one required by other research approaches. This change is reflected not only by the conceptualization of the research problem, but also by the design and proceeding of the research. Designing a research using Facet Theory requires a systematic approach which might require more effort. It is important to emphasize that Facet Theory is not only a quantitative research approach, but also is used as a qualitative research approach.

Professor Paul Hackett is a well-known scholar with a wide and deep understanding in both applied and theoretical psychology, social/environmental/health psychology, research methods and fine art. Professor

Hackett has developed the qualitative or philosophical Facet Theory approach and has applied this to the study of many forms of behaviour including place experience, health, art, animal behaviour, philosophical writing, and so on. Hackett is also interested in the application of ontological accounts of non-human animal behaviour. He has around 200 publications, including 20 books, and holds PhDs in psychology and fine art and is admired not only by his thousands of students over the years, but by his colleagues as well.

In the past two decades, I have had the honour of writing, thinking, and developing with Hackett approaches to the Facet Theory (see, e.g., Hackett and Fisher 2019). Our small but fine “Facet Theory” scholars, base many of their studies on his written and verbal advice.

This second edition will provide the readers a review of contemporary Facet Theory and multidimensional data visualization, quantitative, qualitative, and philosophical research and the use of the declarative mapping sentence.

The emphasis on the mapping sentence offers the readers a better understanding of the principles of Face Theory as a well based alternative for quantitative and qualitative research.

Yael Fisher

2020

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# Preface

## **Covid-19 and Black Lives Matter: Research Implications**

In any contemporary book that is about research methods, it seems almost impossible not to commence with a comment about two major recent world events: the Covid-19 pandemic and the Black Lives Matter movement. Furthermore, rather than simply talking about the events themselves, what is of direct relevance to this book are the consequences of these two events upon the practice of research with human subjects. The first obvious point to be made is that many important changes have come about due to the catastrophic pandemic and the reaction to what has been called the pandemic of racism.<sup>1</sup>

We have become used to the idea of changes happening due to a positive progression. For example, when we think about the economy we envisage growth. When we reflect upon science and technology, we think of progress. Perhaps even more fundamentally, we think about the developments in the way that we relate to other human beings around us

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<sup>1</sup> I actually do not like the use of the term pandemic in relation to racism, as it seems to me to imply that racism, like a virus, is to a large extent out of our control. Racism is a human activity and state of mind and some people chose to be racist. A virus on the other hand is not in large proportion, an elected outcome made by some people.

as we see ourselves becoming more humane. Looking back at the history of research with human subjects, we are used to charting a progression that reflects a progressively more respectful approach.

However, the changes in research practice due to Covid-19 and the scourge of white supremacy and racism are not part of a positive forward progression. Both have caused researchers to reconsider their previous practices in order to counter racism and to protect the well-being of their participants as well as society in general. At the time of my writing over 31 million people worldwide have been diagnosed as having, or having had the virus with very nearly 1,000,000 deaths. The pandemic has been with us for around 10 months and a vaccine seems some time away from being ready. Furthermore, this is the start of the autumn season and there is much uncertainty regarding the usual winter flu season and whether, and to what extent, there will be a winter Covid-19 surge. Indeed, as this is a new virus, we are uncertain if there will be a second wave of Covid-19 infections and deaths at a worse level than the first. In addition to having an impact on our health, the pandemic has increased unemployment and has severely challenged the global economy. Furthermore, another thing that seems to be on the increase is lies and distortions of the truth about Covid-19 by politicians and others.

I do not have the figures to support the following claim but it seems as if racist acts are rising during the pandemic and this also feels like a trend that has been in progress over the past few years. Whether or not these impressions are supported by surveys and statistics is perhaps not the issue here as any act of racism is an act too many and there are very many such acts happening here in the United States. As I have said already, the Covid pandemic has been with us for almost a year and we are hopeful that a cure or a vaccine will be developed over the next year or two. However, racism has been with us for much longer and no “cure” appears on the horizon for this social malady. Racism is one of the greatest scourges within global societies and it is incumbent upon all researchers to do all they can to counter this. When designing and conducting, we must all consider the potential racist implications of how we are going to conduct the research and what will be done with our results.

Much of this book is about qualitative research and researchers from this tradition can play a valuable and unique role in addressing Covid-19

and racism. This is true in terms of attempts to understand the impact that both of these are having through the evaluation of the qualitative narratives and stories that are emerging. Images, photographs, sound recordings, Facebook postings, vlogs, blogs, and many other forms of online expressions constitute a lived experience of both the pandemic and racism. Unlike previous generations, contemporary researchers have a vast array of information available to them on social media and through primary research. It is also likely that qualitative research, and especially that using online materials, will be central to the understanding that we develop of the Covid-19 pandemic and how it impacted upon our lives. Online materials constitute a possibly biased although unedited testimony with regard to the experiences those subject to racism go through.

The declarative mapping sentence offers a framework that may be used to unite the many online and other disparate forms of data about Covid-19 and racism. Furthermore, the declarative mapping sentence forms a framework that allows the unique qualities of a research situation to emerge whilst highlighting underlying commonalities in the data and this framework may also help to guard against preconceived racism. As I have said elsewhere (Hackett 2020), the structure of the declarative mapping sentence is not inflicted upon the information and instead it responds to the data that is gathered and analysed within its framework.

## **The Second Edition**

The world is in a state of constant change and this is never truer a statement than when we consider how we conduct research. The procedures we use to conduct research are similarly always in a state of change. Over the last five decades, this has especially been the case due to the development of the pocket calculator and home computer and then the laptop, tablet, and smart phone which has placed what was unimaginable calculating and processing power in the pockets of most people. Since the first edition of this book was published, there have been many changes in the area of facet theory. Amongst these developments has been my own research that has taken the facet approach and specifically the mapping

sentence further into the qualitative research arena and into bird behaviour research.<sup>2</sup>

A considerable amount of my research over the last few years has appeared in two special editions of the journal *Frontiers in psychology*. The theoretical work that underpins my facet theory research appears in Hackett, P.M.W. (ed.) (2019) *Conceptual Categories and the Structure of Reality: Theoretical and Empirical Approaches*, and the specifically facet research in Hackett, P.M.W. and Fisher, Y. (eds.) (2019) *Advances in Facet Theory Research: Developments in Theory and Application and Competing Approaches*. Many other publications have appeared since the book was first published and there have also been an international facet theory conferences.

My work at Oxford and Durham Universities has led to major developments in the basis of using facet theory and to new ways to illustrate and use mapping sentences, whilst my work at Cambridge University has resulted in publications that have demonstrated the use of the facet theory approach to investigate non-human animals: These developments are reported in this second edition. A foreword is also included by Professor Yael Fisher (rector, Achiva Academic College, Israel). Prof. Fisher is past president of the internationally based Facet Theory Association and has published widely, and is a leading expert, in facet theory.

## Chapter Synopsis

This second edition is considerably changed from the first edition. Chapter 1 however is fairly similar to the original edition and is an introduction to facet theory. A broad perspective is assumed and the theory is described as it exists as both a quantitative and a qualitative orientation to research. Mapping sentences are also initially presented at this stage. Also introduced are components of facet theory such as facets and its

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<sup>2</sup>I have held and continue to hold several appointments that directly support this research at the Philosophy department, Oxford University; the Philosophy department, Durham University; and the Psychology department, Cambridge University.

sub-elements. In Chap. 2, *Ontological Categorisation and Mereology*, a theoretical perspective is assumed and facet theory is considered in terms of how the theory may be used by those interested in the fundamental sub-components of an area of research and how these parts come together as meaningful and experienced whole events. A variety of perspectives are considered including sociology, psychology, and personal construct theory. The philosophical perspectives are also considered and especially some of the structural ontologies that have been proposed by philosophers such as Plato, Aristotle, Maimonides, William of Ockham, Immanuel Kant, E. J. Lowe and Gottlob Frege. Mereology and the relationships between facets and how they are presented in facet theory as a mapping sentence is considered in terms of research that takes both human animals and non-human animals as its subject matter.

In Chap. 3, *Facet Theory and Thinking about Human Behaviour*, I present to the reader a more in-depth evaluation of facet theory in terms of the major components of the theory. I put forward a narrative account of an everyday situation, which I use later in the chapter to illustrate how a mapping sentence account may be developed that describes this 'everyday' situation. The mapping sentence is further explored, in both its traditional and declarative formats, along with how mapping sentences enable the generation of knowledge. The exploration of facet theory in this chapter will provide the reader with the answers to fundamental questions such as what are facets, what are facet elements, what are mapping sentences and structural hypotheses, and how can facet theory be used with both qualitative and quantitative information. The chapter continues by answering more complex queries such as how can mapping sentence be used to design the evaluation of complex situations, and how new mapping sentences are developed for a new study area and how existing mapping sentences are used. Furthermore, several examples of mapping sentences are provided and exactly how mapping sentences are developed is explored. The various roles that facets may be presented and the question asked as to how facet driven research can be analysed.

Chapter 4, *The Declarative Mapping Sentence and Qualitative Facet Theory Research*, concentrates on how facet theory and the mapping sentence have changed and evolved especially over the past decade. My research during this time has been concerned with the development of

the declarative mapping sentence and I present many examples of how, other researchers in different research contexts and I have used this. These include mapping sentences and abstract fine art/making fine art, religion and the process of sacralisation, prison officers' occupational stress, characteristics of the clinical reasoning process, Black Lives Matter, attitudes towards different forms of transportation, and using and evaluating the use of information technology. In presenting the declarative mapping sentence, I also consider the mapping sentence as a stand-alone approach and integrative tool. I consider when and why this tool should be used and the pertinence of the range facet and how this facet differentiates the traditional and declarative forms of the mapping sentence.

Chapter 5, *Facet Theory Research Into Avian Cognition and Behaviour*, is a relatively short chapter and offers an illustration of the seminal use of facet theory with non-human animals. In this chapter, the subject matter is cognition and the behaviour of birds. The chapter commences with an introduction to avian intelligence and how this may be assessed along with comparisons with human intelligence and its evaluation. I present a re-analysis of a data-set that reflected the assessment of cognitive abilities in New-Zealand Robins. This data-set had previously been analysed using principal component analysis, and comparisons are made between the original results and those obtained using smallestspace analysis and partial order scalreogram analysis. The chapter concludes with the development of a two-facet traditional mapping for avian cognition and recommendations are made for future research using this instrument.

In the sixth and final chapter, more unusual uses of the facet theory approach are considered. This commences with the projective research technique of facet sort and then goes on to consider two uses of facet theory that are not actual research approaches: facet mapping therapy and research program coordination. Respectively, I offer facet mapping therapy as a potential approach to counselling in which the mapping sentence and the facet structures are used to explore client issues. I also suggest that mapping sentences may be developed that aid in the coordination of complex research projects. Finally, future directions for facet theory are considered. In the appendices, I include Lustig and Hackett's (2020) book *How to Construct a Mapping Sentence*.

In summary, in this book I:



- consider how category formation is a fundamental human behaviour and review philosophical and neuroscience literature concerning this
- introduce how the mereological process (the study of part and whole) lies central to our everyday understandings (Simons 2000)
- introduce the reader to contemporary facet theory
- provide applied examples of facet theory research from areas that are both traditional and novel research areas for the facet approach
- provide an appraisal of the mapping sentence within facet theory research and as a stand-alone research tool
- propose the mapping sentence as a tool for integrating facet theory and non-facet driven research
- propose the mapping sentence as a tool for project management
- propose facet theory and the mapping sentence as a philosophy of personal understanding of daily existence
- propose the mapping sentence as a guide for understanding and creating fine art

Boston, MA, USA

Paul M. W. Hackett

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Lustig, K., & Hackett, P. M. W. (2020). *Mapping Sentence Pocket Guide*. San Francisco: Blurb Publishers.

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# 1

## Introduction

**Abstract** The first chapter briefly prepares the reader for the content of the book that follows. Facet theory and mapping sentences form the heart of both this chapter and the content of the book that follows. I offer definitions of facet theory and mapping sentences and I introduce the reader to the two forms of mapping sentence, namely, the traditional mapping sentence and the declarative mapping sentence, and how they are appropriate for quantitative and qualitative research respectively. The study of categories is also commented upon as this relates to mapping sentences. Additionally, I propose the neoteric usage of the mapping sentence as a stand-alone research tool without being embodied within full-blown facet theory. A distinctly philosophical outlook along with a qualitative understanding for social research is put forward. Examples of both a traditional and a declarative mapping sentence are given as to illustrate how this tool can be used to understand a specific type of communication. The chapter ends with a description of the chapter to follow.

**Keywords** Facet theory • Mapping sentences • Traditional mapping sentence • Declarative mapping sentence • Philosophy • Aristotle's categories



## Initial Statements

I commence my writing by making initial statements about the contents of this book. These are important, as I believe they prepare readers for the text to come. First, this book is about facet theory and the mapping sentence which are ways of: (1) conceiving the world around us and (2) conducting research into human and non-human animals' experiences and behaviours.

*Facet theory* is an outlook upon the world that advocates the usefulness of identifying major sub-divisions of the phenomena that are being investigated and then further sub-dividing these divisions in order to better understand the phenomena. Having identified these sub-units, scholarship may most profitably proceed by investigating the part to part and part to whole relationships. The parts and sub-parts of an area of enquiry may be represented by writing these within a mapping sentence. The *mapping sentence* is a linguistic framework that can depict the meaningful way in which the components of a phenomenon that is under investigation exist in terms of their part to part and part to whole relationships.

## Introduction

Good research demands that the concepts it employs to be clearly defined. Furthermore, good research also requires for an unequivocal method that enables the establishment of the circumstances under which this concept is applicable, and when this is not applicable, to something in the world (Cartwright 2014). Within this book, I will provide support for the notion that mapping sentences are research devices that fulfil Cartwright's requirements. Mapping sentences may take one of two forms, traditional or declarative, but in either format, they are essentially somewhat rudimentary as they are simple statement in the form of a sentence of prose. Furthermore, mapping sentences are relatively simple research tools to create. With such simplicity in their nature, the reader may ask why

mapping sentences have been used in both applied and theoretical research in a broad array of research situations. This book will consider, and I hope answer, this question, but an initial reason I propose is that by using a mapping sentence the scholar is able to focus their attention in an unequivocal manner on their research questions and to keep their research ‘on track’. Using a mapping sentence in their research design also provides a framework within which the phenomenon that is under investigation is clearly defined.

Both mapping sentences (Levy 1976; Hackett 2014a, b, 2016a, b, 2017a, b, 2018a, b, 2019a, b, c, 2020a, b; Hackett et al. 2011; Koval and Hackett 2016; Koval et al. 2016; Lou and Hackett 2018; Lustig and Hackett 2020a; Schwarzenbach and Hackett 2015) and facet theory (Borg and Shye 1995; Canter 1985; Dancer 1990; Guttman 1954; Hackett 2014a, 2019a, b; Hackett et al. 2019; Levy 1985, 1990, 2005; Lustig and Hackett 2020b; Shye et al. 1994; Tziner 1987), the broader approach to research from which the mapping sentence is taken, are research methods from the humanities and social science. They are specific ways in which a social science research project is undertaken, (i.e., the procedures for designing and executing a research project) are extremely important factors in determining the type and the quality of the information the research produces. Philosopher Nancy Cartwright (2014) emphasises this point when saying that it is crucial that the meaning of the concepts that are being investigated in a research project are specified in a clear way. Continuing, she that there is a further requirement and that is to determine if and when a particular concept applies is applicable to the domain into which you are conducting your investigation. As well as these requirements Nancy Cartwright (2014) goes on to state how “the two endeavours of characterising or defining concepts, on the one hand, and devising methods for determining when they obtain, on the other, must go hand in hand.” (Cartwright 2014, p. 309). Throughout this book I will set out how I believe that the mapping sentence meets both of these needs and offers a framework for conducting well-conceived, appropriately designed and executed research by providing a framework within which research domain of interest is defined and also suggesting how information to interrogate a research question should be gathered and then analysed.

There is a great deal of similarity between both forms of mapping sentences (traditional and declarative). However, they are different and are used in different ways due to the different forms of information that they are used with: quantitative and qualitative respectively. The mapping sentence is able to bridge the boundaries between quantitative and qualitative researchers and in doing this, it provides an approach for conducting mixed-method social science and humanities research. One of the greatest strengths of the mapping sentence is that its use may facilitate a method to reason about a phenomenon that is of interest from perspectives that are both qualitative and quantitative. Canadian philosopher of science, Ian Hacking (1992) has written extensively in this area and has noted the way that different disciplines formulate and take as their own a sense of what is a reasonable manner in which to establish what is, and what is not, valid knowledge. For instance, statistical proofs may constitute a reasonable agreement for the establishment of truth for some disciplines. However, other disciplines see assertions that are valid as being derived from rich textual narrative that convey insight into the lives and experiences of individuals. It is my hope that, through the repeated use of the traditional and declarative types of the mapping sentence a common sense of what is a reasonable basis for statements of validity may be at hand.

## What Is a Facet?

There is a terse answer to the question: what is a facet? A facet is a category. When we think about the word category, we are referring to the classes into which people or things may be divided or allocated on the basis of the features that they have in common. In many ways, categories for building blocks that we use to interpret and make sense of things and events and are the essential conceptual constructs we use to enable us to understand the world in which we live. This is a bold statement but one that is supported by over two thousand years of scholarship. The importance with which the human potential for forming categories and the salient way in which these are used is alluded to by Gottfried Leibniz when he wrote: “A thing that can be divided into several (already actually

existing) is an aggregate of several, and... is not one except mentally, and has no reality but what is borrowed from its constituents.” *Gottfried Leibniz, 1704* (Rescher 1991, p. 50).<sup>1</sup> A century later, another German philosopher Georg Hegel,<sup>2</sup> stressed the pervasive nature of categories by saying: “Even the ordinary, the ‘impartial’ historiographer, who believes and professes that he maintains a simply receptive attitude; surrendering himself only to the data supplied him—is by no means passive in regards the exercise of his thinking powers. He brings his categories with him, and sees the phenomena presented to his mental vision, exclusively through these...” Georg Hegel, *1837* (2010, p. 54)

We must ask however for more detail in our understanding of what a category is, what are the ways in which categories interact, how do we make use of categories in our thinking and speaking, what roles do categories play in our lives, what are the different varieties of categories and can categories have an objective existence, independent of our thoughts and language? These are fundamental questions about human existence that have attracted scientists and philosophers in their attempts to formulate answers. Isaiah Berlin provides a possible answer to these questions by citing Immanuel Kant as saying that the categories through which we all see the world are “... identical for all sentient beings, permanent and unalterable: indeed this is what (makes) our world one, and communication possible.” (Berlin 2013, p. 10). In my writing, I will explore a particular approach to conducting research and into developing knowledge about the world that is based firmly in the understanding that this knowledge is categorial. This approach is known as facet theory which employs a device known as a mapping sentence to categorially depict behaviour and experience. It should be noted that below I will initially consider the metaphysical aspects of facet theory and mapping sentences. However, this will be a brief review of this area and I will delay an in-depth consideration until Chap. 2.

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<sup>1</sup>The above is an extract from a letter sent in 1704 from German philosopher Gottfried Leibniz (1646–1716) to professor of philosophy and mathematics at Leiden University, Burcher de Volder (1643–1709), stating Leibniz’s metaphysical stance (Leibniz 2013).

<sup>2</sup>Georg Wilhelm Friedrich Hegel: 1770–1831.

## What Is Facet Theory?

Facet theory raises questions about the nature of part-hood in relation to the specific areas of research content under investigation. These questions come under the auspices of mereology. When we employ a facet theory perspective, along with using a mapping sentence, we are stating our belief that the phenomena we are investigating is most readily and fully understood by disassembling this into its constituent parts. Facet theory offers one way of understanding part-hood through the use of a mapping sentence. You may at this point be asking why we have to try to understand part-hood and you may feel that parts are natural qualities of events and that these may be investigated. However, identifying the extent of an event in terms of its parts may be problematic as may being able to state that the parts that have been identified actually come together to form a coherent and meaningful whole: in what way do the parts compose the whole? An example may help to clarify these points.

If we think about a physical location that we are interested in evaluating for its ability to satisfy users' needs, several questions regarding part-hood and composition arise:

- What are the boundaries of the location that we are interested in and what makes this a whole (how do we determine where we draw the boundaries to the location)?
- What are the parts of the location (how should we break-down the location when we try to assess satisfaction with the place)?
- If we can identify separate components of the location for the purpose of evaluating satisfaction with these, how and indeed do these parts of the location come together in a meaningful sense to form the place as a whole?
- What are the specific relationships between the parts we have identified as being separable?
- What are the relationships between the separable parts and the location as a whole?
- Who are the users and what are the characteristics of those users that relate to satisfaction with the location?

- Do all users understand the whole of the location, its parts, and the ways that these come together in the same way?

There are other questions that could be asked but those listed above serve to illustrate that it may not be a simple thing to identify what is the whole phenomena we are interested in, its parts and how these are assembled. Other questions that may be asked regarding part-hood can be illustrated if we continue the above example. Let us now imagine that the location we are assessing is a large shopping mall. We are now required to ask the following questions:

- What is the extent of the mall (does it include the car parks for the mall, access roads, the transit system that runs through the mall, the larger detached stores around the periphery of the mall site, access to surrounding towns, bus and train services, etc.,)?

It can be seen that it is not a simple thing to define the extent of the whole mall—the extent of the phenomena under investigation. With this ambiguity in mind, the extremely important question therefore arises:

- Can a thing called the ‘mall’ be meaningfully said to exist (does it make sense to think of the mall as a whole or should we content ourselves with investigating the parts we have described above)?

The converse state also pertains and we must ask:

- Can the separate parts of the mall be said to have a coherent existence separate to their existence as a part of the mall (does it make sense, and is it a legitimate practice, to investigate individual components of the mall)?

Finally, if we do decide that the mall can be identified as a meaningful whole with the meaningful sub-components that we noted above, we have two extremely important questions to answer:

- How do the parts of the mall come together to form a whole (this is a question that is asking how, in the real world, do the parts of the mall come to possess a meaning as a mall, do the parts just sit next to each other relatively independently, are the amalgamations, do they merge to form composite identities, are they concatenations with different meanings as a whole dependent upon the order of their assembly, etc.,)?

Having thought about the many ways that part-hood could be present within the mall we then have to answer the question:

- How do we bring our research into the components of the mall together to allow us to make statements about the mall and its parts?

The above example of a mall is, I hope, useful in highlighting some of the dilemmas that are associated with any research project into any phenomena. Facet theory explicitly identifies the nature and roles of part-hood in research, but it does not create the part-hood issues which are present to varying extents in research regardless of how it is conceived. It is also important to note that whilst the parts of the mall are obvious in the example the illustration I gave could have been very different in terms of its subject matter. As an illustration of this, we can think of a research study that was concerned with the development or appraisal of a cognitive test. The same questions I listed above could be asked in this case as well. For instance:

- What are the boundaries of the test that we are evaluating or developing and what makes this a whole (how do we determine where we draw the boundaries to the test)?
- What are the parts of the test (how should we break-down the test when we use this to assess cognitive performance)?
- If we can identify separate components of the test for the purpose of evaluating cognitive performance, how and indeed do these parts of the location come together in a meaningful sense to form a measure of cognitive performance as a whole?
- What are the specific relationships between the parts of the test we have identified as being separable?

- What are the relationships between the separable parts of the test and the test as a whole?
- Who are the users and what are the characteristics of people taking the test that relate to performance of the test?
- Can a thing called ‘cognition’ be meaningfully said to exist (does it make sense to think of the cognition as a whole or should we content ourselves with investigating its parts)?
- Can the separate parts of cognition be said to have a coherent existence separate to their existence as a part of the test (does it make sense, and is it a legitimate practice, to investigate individual components of the cognition)?

The above are a few examples of how part-hood raises many questions that a researcher has to at least attempt to answer if they are to design and understand their research project.

Facet theory as an approach is explicitly concerned with part-hood as this is associated with a research domain and it proposes answers to the above question in the form of a mapping sentence for a research area. Facet theory is a categorical approach to research, an outlook on research that considers the categories and sub-categories (together these form the parts) of some aspect, for instance, of a person’s existence (the whole in a specific sense). Within the world of research into the lives of human and non-human animals facet theory approaches incorporate philosophical ontologies (at this point we can think of ontology as being the study of the fundamental categories of existence within a specified context) with explicitly stated meaningful mereologies (empirical mereology is the real world study of the part to whole relationships of categories of existence). This book forms an account of the basics of the facet theory analytic approach, its application, and some of its contemporary extensions. However, especially in this second edition, the book lays particular emphasis upon the philosophical, qualitative, and even linguistic aspects of the theory. With this in mind, the book is a research-based reflection upon the development, applied utility and the conceptual underpinnings of facet theory and mapping sentences often as these have been used in my own research. It will become clear as the book progresses that I place considerable emphasis upon the mapping sentence, as, I will argue, the



mapping sentence constitutes what I consider to be the single most important and powerful aspect of the theory. In the text I initially chart the development of the facet theory approach, both as I have used this in my teaching and research over the past three decades, and as used by other academic and research professionals. I also note David Canter's investigative psychology, which was an important advancement in the facet approach (Canter and Youngs 2009) as well as his very recent forays into qualitative facet theory (Canter 2019).

However, as I have stated already, I consider the mapping sentence to be a cardinal aspect of the theory and more specifically in this book, I neoterically propose the mapping sentence as a stand-alone research instrument, and a project management and research presentation tool. Alongside the traditional mapping sentence, I offer the declarative mapping sentence as a template and rationale for qualitative research. This form of mapping sentence is derived from the traditional mapping sentence but has no stipulated outcome variable to guide, and in some cases to shackle, the interpretation of the information gathered. I also promote the stand-alone mapping sentence and the process of facet modelling to expiate some of the difficulties that arise in both traditional facet theory research (e.g., the limited number of facets in a study) and traditional multi-variable research (with its tendency to conduct atheoretical and non-cumulative research). Thus, in the present text, I will bring together contemporary facet theory based research, and suggest future directions the approach may take. At the heart of my suggestions are the propositions that both qualitative and philosophical research can benefit from adopting an orientation towards their research that incorporates facet theory in its extended form of the declarative mapping sentence.

Within this monograph, the broad area of facet theory and basic information about the facet theory approach are reviewed, as are both its applied and more theoretical research perspectives: However, throughout, I emphasise the use of the theory in a qualitative research context. To these ends, examples of the application of the theory are given without statistical formulas or the inclusion of analysis algorithms for formal facet theory analyses (such traditional forms of analysis are statistical: Smallestspace Analysis (SSA), Multidimensional Scalogram Analysis (MSA) or Partial Order Scalogram Analysis (POSA)) as these are more

suiting to a very different approach to facet theory to the one I adopt. The monograph takes the form of a research-based narrative rather than being a collection of readings or a formal guide as to how to conduct facet theory research.

This book differs from previously published books on facet theory as it is centred upon the possibilities of qualitative facet theory and the research-based development of the mapping sentence as a stand-alone approach, as a tool to theoretically structure research projects: an approach that guides research design, execution, and analysis. However, my understanding of facet theory does not inevitably employ the analysis of data structure or regional hypotheses implicit in traditional facet theory research (Hackett 2016b).

I also deliberate upon the use of the mapping sentence as a tool for integrating existing and contemporary research that originates from outside of facet theory and I present facet theory and mapping sentence applications to areas of research that are novel to the approach, such as: the development of an understanding of fine art painting (Hackett 2016a) and three-dimensional artwork (Hackett 2017a) with the subsequent production of artwork based upon this taxonomic knowledge. Furthermore, I illustrate the use of a mapping sentence and the theoretical foundations of facet theory with clients within psychotherapeutic situations and as a component of therapeutic interventions, which I call facet mapping therapy (Hackett 2019b).

Reflecting upon an established theory from viewpoints other than those traditionally associated with that theory may avail interesting and useful insight about the established theoretical approach and may assist in extending the approaches utility. An example of this observational 'side-step' is one that may allow the use of methodology from an approach without the constraints of the fully developed theory. Moreover, I opine that by taking a theoretically abbreviated, some would say debased and illegitimate, consideration of a theory it is sometimes possible to develop novel understandings and applications for the established theory. This may also suggest possible applied areas of utility for the relatively theoretical methodology used and perhaps for the 'full-blown' theory itself.

The facet theory approach incorporates the notion that an excellent way in which to produce research findings that are valid and reliable, a

research domain has to be broken down into parts that are significant to its subjects and then these components are pull together as a meaningful whole. The manner in which this mereological understanding of a research domain is broken-down and then reassembled is through clear and explicit establishment of context specific definitional categories. The importance of the employment of such categories is supported by the likelihood that research that proceeds without clearly defined content will at best produce results that are unlikely to contribute to a cumulative and comparable knowledge base in regard to the content. Undertaking research without a clearly defined content may also result in errors of validity and reliability of then research. Within the social sciences facet theory has addressed mereological research design issues producing categorical definitions for a wide range of research domains allowing the production of research results that explicitly relate to given areas of research, (Hackett 2014a). Facet theory approach to social science research is founded upon the establishment of respondent defined categories and the exploration of how these categories come together within a person's meaningful experiences.

I argue that the most important and indeed unique aspect of facet theory research is the mapping sentence. The mapping sentence has several functions within the approach. For example, the mapping sentence:

- forms as an intricate series of connected hypotheses that form a coherent whole;
- it is a device for interpreting and communicating research results;
- it constitutes an apparatus for enabling comparability and standardisation between research findings.<sup>3</sup>

The mapping sentence is an extremely flexible tool and will form the heart of the treatise I put forward in this book. During my writing, I will elaborate upon how I have used the mapping sentence both within research that has been designed using facet theory as well as in research projects that were not conceived within the facet theory framework. In

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<sup>3</sup>A mapping sentence may be defined as equivalent to the formal terms of notation found in set theory.

these latter instances, I have developed and used the mapping sentence as a stand-alone theoretical framework through which understanding may be developed about the world of human and non-human animal behaviour. To emphasise the integral role that the mapping sentence plays within a research project that has been designed throughout its whole process, Dov Elizur says:

The mapping sentence presents the complete research design in the form of a sentence which is easy to comprehend, even without acquaintances with the terminology of set theory.

Elizur (1970, p. 55)

As well as being easy to understand, the mapping sentence is a means through which the underlying psychological features or variables, or what we may call the constructs, that are the focus of a study may be clarified through the use of facet theory approach, as the facet approach, “provides a systematic way to develop clear theoretical constructs.” (Yaniv 2014).<sup>4</sup> The ability to be able to define the constructs in a clear and unambiguous manner is essential when one is attempting to establish the validity of the findings that arise from a research study. This statement is largely self-obvious but often ignored. It is obvious when one considers that a valid statement is one that is addressing or talking about what it is claiming it is addressing and if there is any ambiguity concerning what it is your research is addressing then it becomes impossible to make valid claims on the basis of this research.

Later in this book the process of conceiving of and then constructing a mapping sentence in order to bring clarity to the definition of both constructs and the overall area of a piece of research will be considered in some depth. However, in order to familiarise the reader with a mapping

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<sup>4</sup>Yaniv (2014) states that “Facet Theory offers a unique perspective on the issue of construct clarity and is particularly suited to bridging the gap, presented by Suddaby (2010), between Eisenhardt (1989) and Dyer and Wilkins (1991) regarding the role of constructs in theory building.” Yaniv notes how on Eisenhardt’s understanding of a construct these are required parts when building a theory whilst Dyer and Wilkins’ conceptions place the construct in a position of emergence from the data gathered. “Faceted definitions of theoretical constructs put together these two views.” Yaniv (2014).

sentence it is useful as this point for me to provide some details about how mapping sentences are used.

## Using Both Traditional and a Declarative Mapping Sentences

In all forms of a mapping sentence, multiple mutually exclusive categories define the content area of interest. To clarify understanding of what I mean by this statement, I offer an example mapping sentence that I will present in both traditional and declarative forms.

If we imagine that I am interested in analysing the exchanges of ideas that I have had with colleagues about Aristotle's metaphysical writing on *Categories* (Aristotle and Ackrill 1975), I may decide to write a mapping sentence about these exchanges and therefore construct a mapping sentence to account for these exchanges in the following ways. First, I could write a traditional mapping sentence that is an account of how successful I felt that any particular exchange I had had about Aristotle's *Categories* had been:

In the above, I formulated a traditional mapping sentence that would enable me to design a piece of research that was aimed to measure the particular variable of success associated with my experience of communications in regard to this part of Aristotle's scholarship. However, I may instead develop a mapping sentence in its declarative form with does not specify a specific form of output measurement within its content but rather clearly defines the subject matter of the research which may be associated with numerous outcomes or none:

When interpreting a mapping sentence the reader commences as if they were reading an ordinary English language sentence.<sup>5</sup> In the example I provide, the letter (x) designates an individual person who is the subject of the sentence. One then continues by reading through the sentence selecting one of the facet elements (these are the columns of italicised words) from each facet (the emboldened 'facet' names that label the vertical element lists of 'types' of content area) to form a sentence. In the cases

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<sup>5</sup> Mapping sentences have appeared in languages other than English.

**facet (a)** **facet (b)**

Person (x) being an, {*American*} academic, from the disciplines of, {*philosophy* }  
{*British* } {*gender studies*}  
{*psychology* }  
{*fine art* }

**facet (c)** **facet (d)**

submits a, {*question* } as part of a dialogue upon, {*categories in general*}

{*statement*}

{*reply* }

{*Aristotle* }

{*other philosophers* }

**facet (e)**

with the aim of, {*resolving a specific problem* } and understand this exchange to

{*growing general knowledge* }

{*for other instrumental reasons*}

**range**

have been, {*of greater success*} in terms of their intention within the specific dialogue.

{ *to* }

{*of lesser success* }

**Fig. 1.1** Traditional mapping sentence for academic dialogue

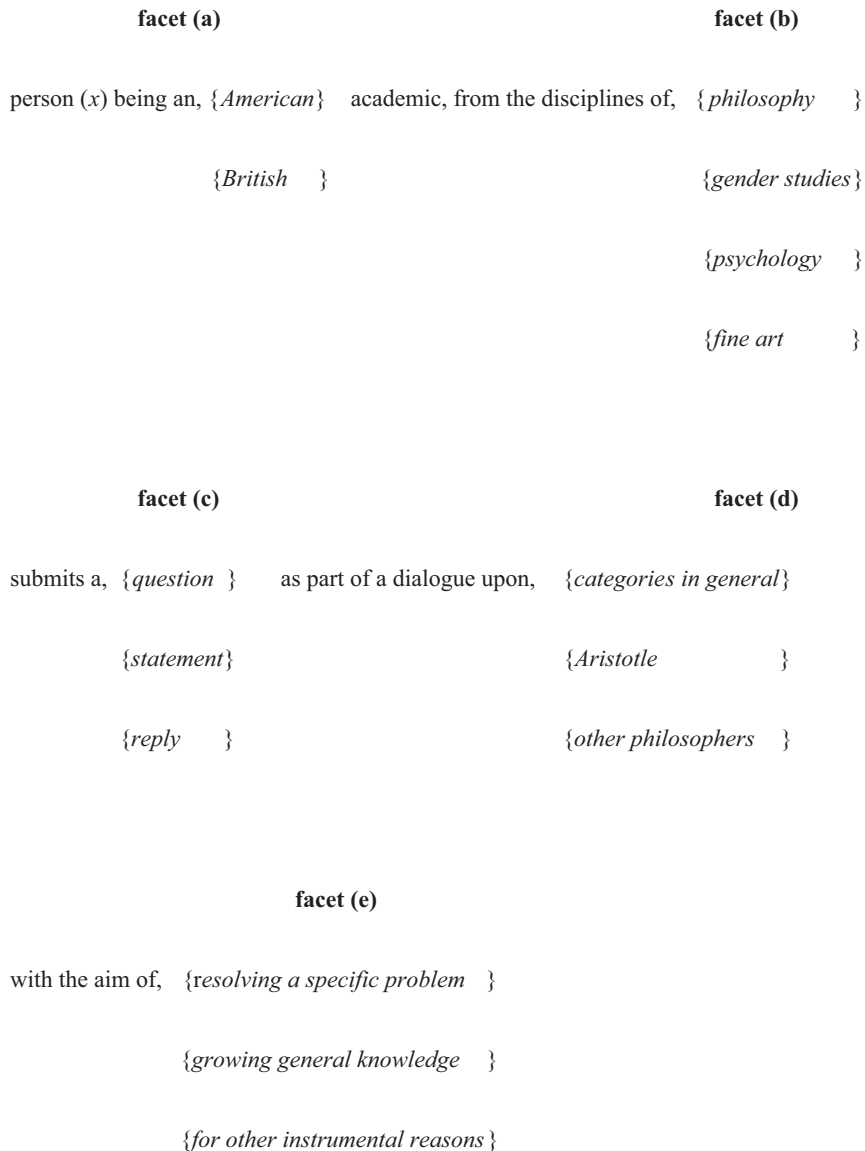


Fig. 1.2 Declarative mapping sentence for academic dialogue

of the mapping sentences in Figs. 1.1 and 1.2, the structural content of the mapping sentence enables any one of my exchanges with colleagues to be dissected into its pertinent sub-components (this statement is of course dependent upon the assumption that I have adequately typified all possible exchanges by using the facets and elements that I have selected). When it is read as a sentence, the mapping sentence permits the totality of any communication about the *Categories* that I have had with colleagues to be described and understood. This example mapping sentence is an initial attempt to describe the content area of academic discourse. The declarative mapping sentence in Fig. 1.2 can be understood by the preceding sentence. However, the traditional mapping sentence in Fig. 1.1 has an additional facet: a range facet. Through the inclusion of this facet, I have specified that my interest is focused exclusively upon how successful I understand each communication to have been. By including the range, I also provide a clear statement as to how success in regard to a communication about the should be measured and in this case that is somewhere between being of greater to lesser effectiveness. The range would typically be assigned a numerical value range, such as from 1 to 5. However, by stating a range facet I am limiting my interest to this one way in which a person may react to the content of the communication I am interested in (e.g., the *Categories*). In qualitative research, it is most likely that the researcher will have a broad interest in a person's understanding of the subject matter and will want to gather rich information that is not shackled but the definition of a range facet. In this case, the declarative mapping sentence is the appropriate choice.

Even restricting myself to just the limited number and type of exchanges that may have occurred between my colleagues and I, the mapping sentence and its facets are almost certainly inadequate to fully describe all of the exchanges that occurred. However, a mapping sentence may progress from being a theoretical initial mapping sentence to a full-blown mapping sentence. It achieves this move from being a hypothesis of a content area to become a 'valid' representation of a content area through rigorous scholarship and often empirical investigation. Facets and their elements are added, deleted and have elements added or elements deleted, as these parts of the mapping sentence are pertinent to the area of inquiry. For example, *facet a* in the example mapping sentences in



Figs. 1.1 and 1.2 is a facet that embodies the country of origin of a participating academic from whom I engaged with in a communication. This facet has two elements: British and American. After examining the data that has arisen from the content area the mapping sentence defines (in this example, academic exchange) it may be apparent that country of origin does not have an important effect in the exchanges. Therefore, this facet may be deleted from the mapping sentence. However, we may feel that other descriptive facets may be pertinent influences upon our data. For example, we may come to believe that the type of institution a person works at is an important facet (here the elements may be community college, research university, new university, Red-Brick, etc.). In this instance, this facet, with its appropriate elements, would be incorporated into the mapping sentence and evidence sought to justify their inclusion. Facet elements are treated in a similar fashion and added or deleted on the basis of their explanatory utility to the subject area of the mapping sentence.

It is important to note that the mapping sentences in my example are hypothetical descriptions of the academic discourse content area. In research that utilises a mapping sentence approach, existing research literature is examined to identify the usefulness and applicability of mapping sentence that have been developed and used in published research. When such a mapping sentence is discovered, it may then be used to design subsequent studies. Furthermore, if after a literature search it is found that no mapping sentence exists for the area with which you are concerned it is possible to look at research that does not use a mapping sentence or facet theory in its design. Such publications may be inspected to see if a theoretical structure for pertinent aspects of the research or variables are present which may be adapted and incorporated to form the basis for an initial mapping sentence. It is therefore important to note that mapping sentences may therefore be used within an overarching conception of facet theory or they may be employed as stand-alone instruments for guiding and interpreting research that is concerned with complex situations or events.

## Conclusions

In this chapter, I have briefly introduced both facet theory and mapping sentences whilst at the same time illustrating the two forms of mapping sentence. I have also distinguished between these two mapping sentence types (declarative and traditional mapping sentence) in terms of their applicability to qualitative and quantitative forms of research. In this first chapter, I have offered a consideration of some attempts that have been made to understand complex human behaviour in both a quantitative and qualitative sense. In the second chapter, this understanding is enhanced by drawing upon research in the areas of philosophy, metaphysics, ontology, mereology, neuroscience, psychology, and other select areas. The pervasive human characteristic or predisposition of making and using categories of objects and events will be considered. Furthermore, I review how categories are employed as a means to allow the simplification of the perceptual process, and the way in which animals (both human and non-human) understand their worlds. Facet theory and the mapping sentence are defined as category analysis procedures.

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# 2

## Ontological Categorisation and Mereology

**Abstract** Facet theory identifies parts or categories of behaviour or experience and investigates these through a process of hypothesising, research design, data gathering, and analysis. The categories that individuals use to dissect their understanding of their worlds has long been an important area of study by philosopher, psychologists, sociologists and others interested in attempting to understand the human condition. Consequently, Chap. 2 ‘Ontological Categorisation and Mereology’, will form a prolegomenon in which I step back from facet theory and take a multi-disciplinary look at the human propensity to use categories, in structuring their understandings. Philosophers, who have written about categories, such as Aristotle, Kant, will be selectively presented. As this book is a short text, the examples I present will not form a comprehensive overview of such scholarship but rather will be chosen examples of certain ways of thinking about categories. Following this, I will present other academic approaches to study categories drawn from other academic disciplines. Categorised events may be further manipulated as these cognitions form representations of our daily lives where the imposition of order upon categories is a logical next step in arranging our perceptions. For example, a visual ethnographer may collect a series of categorial images and then

arrange these by a narrative or chronological ordering and I will briefly consider ordered representations. By the end of the chapter, the reader will be conversant with the basic ideas surrounding human representation and usage of categorical and ordered knowledge.

**Keywords** Categories • Mereology • Ontology • Facet Theory • Mapping Sentence • Neuroscience

## Introduction

The mapping sentence is a formal statement of the components of a behavioural or experiential phenomenon and their interrelationships, whilst facet theory provides a theoretical justification for conceiving of the world in terms of its parthood relations. Mereology is the study of part to whole relationships and is an interest in what is a fundamental life process.<sup>1</sup> My understanding of the world that surrounds me is entwined in a collective of fragmented multiplicities comprised of aspectual parts and perspectives of objects and events. Furthermore, these understandings interact with both my existing cognitions and between myself and other people. However, there is little agreement about “how many (fundamental) parthood relations there are. *Compositional monists*... say there is exactly one; *compositional pluralists* ... say that there are at least two, presumably associated with different ontological categories and perhaps governed by different principles.” (Gilmore 2014, p. 157. original emphases). Typically, however, I experience my world as a meaningful whole with multiple parts and within this social and physical universe is located my self-construal.

In this book, I am concerned with the understanding of the human being in terms of both the separately identifiable parts of human life and as a total lived experience. I am not concerned with the mensuration or other forms of assessment of the normal, average, typical, atypical, or

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<sup>1</sup> It may be argued that understanding mereology is essential to understanding ontology, or that mereology is essential to ontology. Indeed, when considering research into human and non-human animal behaviour the distinction between mereology and ontology may not be clear.



abnormal human being. Rather, I am interested in appreciating, and in some cases measuring, as a form of empirical understanding: anthropometric and psychometric measurement and their extension from traditionally quantitative to qualitative conceptions of being. Anthropometry measures all of the physical aspects of the human body. For example, overall height and weight along with more detailed metrics of the length the elbow to the fingertip, foot size, head circumference and distance between an individual's eyes and as well as these static measurements, range of motion is also recorded. Equipped with this information equipment, buildings, clothes, vehicles, and so on, can be manufactured that fit a person or an aggregated array of different people.

Physical measures are one way in which the individual human being may be understood within their experiential lives. In an earlier era Leonardo Da Vinci's Vitruvian Man of 1490 (see, Magazù et al. 2019) embodied the notion of man (sic) as a metric of the world, which is based on the Roman, architect Vitruvius who claimed in *De architectura*<sup>2</sup> that the figure of man embodied the proportions of classical architecture. Here, the built world is understood in reference to the human form. In his books *Designing for People* (2003) and *The Measure of Man* (1960) Henry Dreyfuss incorporates human physical metrics when he describes his approach to industrial design. Dreyfuss' books and human factors research in general, offer an understanding of situated human behaviour as they study the impacts of everything from the height of tables, the size and positioning of chairs, to the width of the doors and the measurements from many other physical features of the environment. Here, anthropometric measurement is used to depict the human body in terms of its relationship to the environment. In his book, *The Measure of Man and Woman*, Allan Tilley and Henry Dreyfuss (2001) set forth content indicative of their book's title and provide a series of measurements of human beings, which they relate to everyday human activity. One approach to depicting the person within their environment is that of human factors (Hendrick et al. 2009) in which physical experiences are perhaps inseparably bound into psychological appreciations and attempts to understand and to measure the human quotient. In this text I will be

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<sup>2</sup> 'Art Directory GmbH'. [www.Vitruvius-pollio.com](http://www.Vitruvius-pollio.com). Retrieved 12-23-2013.

incorporating attempts to understand and appreciate the human and non-human animal's physiological, psychological, and philosophical make-up or quotient by incorporating this within the categorial system of the mapping sentence.

## Categories and the Properties of Experiential Events

It is impossible to think without using categories  
Gorman and Sanford (2004b, p. vii)

All that we can perceive is thus determined by the order of sensory qualities which provide the 'categories' in terms of which sense experiences alone can take place.

Friedrich August von Hayek (1999, p. 167)

Categorization is the mental operation by which the brain classifies objects and events. This operation is the basis for the construction of our knowledge of the world. It is the most basic phenomenon of cognition, and consequently the most fundamental problem of cognitive science.

Cohen and Lefebvre (2005, p. 2)

When reading the above quotations (Gorman and Sanford 2004b; von Hayek 1999; Cohen and Lefebvre 2005), it appears that the allocation of items, objects or events to categories are fundamental human activities (we will see later that non-human animals also employ categories) and that human understanding of the world is based upon the categories we use to achieve our understanding and communicate this.<sup>3</sup> It is possible, and indeed reasonable to think of the categorial classification of events as being the most fundamental way of arranging the universe as that animal apprehend this. In this chapter I will consider a selection of ways in which human and non-human animals have employed categories and categorisation in order to structure and help facilitate their understanding

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<sup>3</sup>This is seen in the literature about the psychological development of the child, ethological studies of animal behaviour or writings about the philosophical characteristics of human beings.

of the world. This brief review will consider categories as they have been viewed from several scholarly perspectives whilst concentrating upon scholarship from psychology, philosophy, and neuroscience: these disciplines have all been employed to forward explanations of the category-forming propensity. Categories are trans-disciplinary and this characteristic is reflected in the multi-disciplinary research that has been conducted in this area, the insights that have arisen out of the numerous multi-disciplinary books that have appeared on the subject of categories<sup>4</sup> and how categories are often used within a mereological framework (Bochman 1990; Manley 1957a, b). Categories are so pervasive and important to human and non-human animal life that error in the use of categories is also the focus of academic study (Magidor 2013).

An example of the use of a categorical system is the Periodic Table (see, for example, Jackson 2020; Coventry House Publishing 2020) which is a widely used example of categorisation within the physical sciences. In this table, the physical matter that makes-up our world (118 chemical elements) is placed within a tabular format in which numbers and symbols describe an element's location. The Periodic Table is internally structured by similarities in the contents of the elements. The Periodic Table is also a category-based understanding of our universes that exists in several versions. Each of the versions presents essentially similar information as that presented in the standard Periodic Table (for instance, White 1934) of horizontal and vertical rows and columns but does so in different configurations, for example, as a spiral (Benfey 1960; Moran 2012). In all these diagrams, context is important with each different presentation of the table, "emphasizing a different aspect of the situation." (Bookstein 2014, p. 55). The periodic table and its use in the physical sciences is an example of the use of categories by a discipline in order to facilitate understanding of the world. Below I introduce some other disciplines that have used categories towards similar ends.

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<sup>4</sup>Seminal examples of this cross-disciplinary scholarship are given in many edited collections including notably: Carrithers et al. (1985) Gorman and Sanford (2004a).

## Non-human Animals Use of Categories

As noted by Asen and Cook (2012) it is a characteristic for all animals to categorise the stimuli that impinge upon them. Moreover, they state that categorising is imperative to many aspects of their lives. Greggor and Hackett (2018) reviewed the use of categories by non-human animals and commented that a brain is not even necessary for categorisation to take place in sea anemones who are able to identify food, predators and conspecifics from their busy surroundings and then to behave in a category-appropriate manner. These authors also comment upon how important correctly categorising events and phenomena is to a non-human animal in order to not miss food or to avoid predation or potential mating opportunities. As a consequence of such imperatives, selective pressures have honed the ability to categorise. It is important to note that categorisation in non-human animals is not a homogenous process but rather varies in its complexity and the behavioural responses that are committed based upon categorisation. Furthermore, whilst a non-human animal may be able to categorise this does not imply that they discriminate stimuli using conceptual representations.

As well as naturally occurring categorisation, non-human animals have been trained to employ many different forms of categorisation in order to solve problems. For example, Watanabe et al. (1995) trained pigeons to categorise the paintings of Picasso versus Monet and Avarguès-Weber and Giurfa (2013) trained honeybees to use the abstract concepts of sameness and differentness in order to solve problems.

Does this mean that bees, pigeons and humans all categorise the world in a similar, cognitively complex way? The evidence would suggest not. In the case of bees, their abstract categorisation abilities are limited to very specific flower-finding contexts. Meanwhile, many examples of pigeons' categories can be explained by rote memorisation and overlapping perceptual similarity, rather than by rules or abstract concepts that generalise categories to new stimuli (Huber 2001). Therefore, although impressive examples of categorisation exist within the animal kingdom, not all animals deal with categories similarly.

In addition to research into non-human animals' abilities with regard to the formation and use of categories, human animals use categories within a wide variety of contexts and I will now appraise the use of categories in a variety of academic disciplines.

## Mathematical, Computing, Artificial Intelligence and Library Classification Approaches

A pertinent approach to the understanding of individual events and their relationship to other events, including the categorisation of events, is that of set theory (see e.g., Brauer 2006). Brauer defined a set as, “a collection of definite distinct objects of our perception or of our thought, which are called elements of the set.” (Brauer 2006, p. 4) and where, “Knowledge is assumed in rough set theory to be a classification of objects into categories.” Polkowski (2013, p. 146). Formal Concept Analysis<sup>5</sup> (Ganter et al. 2005) is an approach to identifying conceptual structures within a set of data. Formal Concept Analysis has been applied to areas such as psychology, musicology, linguistics, medicine, engineering, ecology and many others (Priss 2007). Formal Concept Analysis uses graphical visualizations to display the structural relationships within the data under investigation.<sup>6</sup> Priss also stresses the efficacy of Formal Concept Analysis for social scientists when analysing qualitative data where statistics and Formal Concept Analysis may be successfully combined.<sup>7</sup>

Computing is another area in which categories have been extensively used. The Association for Computing Machinery's Computer Classification System provides a categorical (hierarchical) directory to their digital library, which includes a 'subject tree', of dendritically

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<sup>5</sup>The term Formal Concept Analysis was developed in 1982 by Rudolf Wille (1982) and has grown to include three international conferences each year on this subject (ICFCA, ICCS, and CLA). Formal Concept Analysis attempts to form fuzzy sets and to establish fuzzy logic through bringing together concepts.

<sup>6</sup>Facet theoretical approaches also graphically display relationships within a data set.

<sup>7</sup>Priss (2007) cites Formal Concept Analysis as useful within information science, as classification systems, the construction of thesauri and library catalogues.

structured levels each with multiple nodes. Within the computer classification system, a user may explore the categorical data by, “drilling down from more general categories to narrower subjects and then to specific topics... (with the system) ... supporting the user when he or she is interested in finding those documents which are described by certain terms or categories.” (Carpineto and Romano 2004). Fuzzy logic is another mathematical area related to categories, which has found utility in the behavioural sciences. Fuzzt logic has been developed through the questioning of classical set theory and the development of the notion of fuzzy concepts (Belohlavek and Klir 2011). Categories are important in Fuzzy logic, which is related to the notion of many, (and perhaps infinite) value logic, where the ‘true’ answer to a proposition has many possibilities (Malinowski 2001).<sup>8</sup> Illustrations of the use of, and exploration into, categories from within the computer sciences literature are many and extremely varied. A form of library cataloguing is also known as facet analytic approach and whilst this is distinct from facet theory as presented in this book, many similarities exist between the two (see e.g., Hall (2012) for a contemporary review of facet-based library catalogues). The approach was originated in the work of S.R. Ranganathan who developed a five-category system for classifying books.<sup>9</sup> It is interesting to note in the context of this book that Moss (1964) stated that Ranganathan’s system of five categories (Personality, Matter, Energy, Space, and Time) is analogous to Aristotle’s Categories; however, he also states that Ranganathan did not recognise these similarities.

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<sup>8</sup> There are several conceptual areas that have been viewed through a ‘fuzzy’ perspective: fuzzy sets, fuzzy number, fuzzy interval, all of which encompass imprecision, ambiguity and uncertainty. The fuzzy approach has been widely employed in artificial intelligence (Janr et al. 1997). Here, neural fuzzy logic, a human-like form of reasoning, is combined with artificial neural networks, which have a connectionist structure in their neural networks, in the production of fuzzy neural networks. By incorporating both interpretable and accurate criteria, neuro-fuzzy hybrid intelligent systems produce rules, which can approximate human decision-making.

<sup>9</sup> Ranganathan developed the colon library classification system (1931, 1933).

## Sociological Approaches

Sociology is a discipline that heavily rests upon the use of categories, for example, the division of social structure into social classes and I could choose examples from many writers to illustrate this point. However, I have selected two seminal sociologists, Durkheim and Goffman, as their work exemplifies two important strands of thought within sociology: what may perhaps be thought of as an intra-social/inter-individual perspective (Durkheim) and a more intra-social/intra-individual outlook (Goffman).

Durkheim and Mauss (1967) adopted a sociological perspective in their investigation of categories. They looked beyond the individual and his or her category system to consider the influences of society upon how people classify or categorise their worlds and how systems of categorisation differ between societies. In doing this, these scholars identified what they termed the social classificatory function. Their conclusions were based on research into traditional Chinese, Australian aboriginal and the North American Zuni societies. In these communities, they discovered symbolic classificatory categories which corresponded to categories of societal understanding. The meaning of this statement is that societies form indigenous categories for events such things as number, space, time and other forms of socially shared ways of thinking about their world. Many other sociologists and considerable amounts of sociological research have included categories or categorisation as one of their pertinent features.

Ervine Goffman is an example from within sociology in which the utility of using categories to simplify understandings of a social context is recognised. When talking about how a sociologist may understand the information he or she is analysing, Goffman emphasised the usefulness of categories when he said, “Instead of having to maintain a different pattern of expectation and responsive treatment for each slightly different performer and performance he can place the situation in a broad category around which it is easy for him to mobilise his past experience and stereotypical thinking.” (Goffman 1959, p. 26). However, Goffman recognises that the use of categories is not without its problems in which respect he

notes that categories play a fundamental part in the constitution of sociological knowledge (and indeed in the sociology of knowledge). “How can I be sure, say, of my Sociological analysis of American middle-class in view of the fact that the categories I use for this analysis are conditioned by historically relative forms of thought... (and that) ... I am myself a member of the American middle-class?” (Goffman 1967, p. 13). Goffman’s perspective and understanding explicitly locates categories as intra-individual concepts in interaction with social culture and in effecting sociological epistemology. However, the examples of both Durkheim and Goffman succinctly illustrate the breadth of scope and frequency of use of categories in sociological thinking.

## Psychological Approaches

Categorisation and categories are central within a great deal of psychological thinking. A very obvious example of categorisation may be taken from behavioural psychology in which an event’s (or stimuli’s) categorial membership may be both differentiated and generalised. Stimulus generalisation and differentiation are both pertinent aspects of behavioural and conditioning approaches to understanding human and animal learning. Both generalisation and differentiation require a stimuli to be understood as belonging to a category of events greater than themselves in order for generalisation and discrimination to occur effectively. For example, if a human or non-human animal receives reinforcement (reward) when they perform ‘a certain’ behaviour at the onset of the stimuli, then higher rates of this response will occur when this specific stimulus is presented in the future than if the presentation of the stimuli had gone unrewarded. It has been found that some generalisation of the rewarded response will occur to *very* similar stimuli. In this way if an increasing number of stimuli exemplars are reinforced and stimuli that are not category members are not reinforced a general category of stimuli is produced and all members of this category will elicit the response. In this situation a category has been produced and the literature would suggest that birds and animals have a propensity to form categories under these circumstances (it has



been argued that human animals may require fewer exemplars to establish categories than non-human animals).<sup>10,11</sup>

Categorical systems and the process of categorisation are present in much research from within another orientation towards psychology, that of cognitive psychology. However, categories have tended to not be separate and prominent areas of enquiry or subjects that are investigated in and of themselves within cognitive psychology. Rather many theorists have included categories within other areas of their work. An example of this research is that of Jean Piaget who developed a categorical classification system for the child's cognitive development (Piaget 1923, 1937a, b, 1945). Whilst being a sequential regimen for how a child develops his or her cognitive skills, the categories present a model for understanding how cognitive skills develop and how children employ these skills in their lives. According to Piaget, the child progresses through: *sensory-motor*, *pre-operational*, *concrete operational* and *formal operational* stages, which are exemplified by categories of the type of knowledge and interaction the child engages in at that stage of development. Furthermore, Piaget states that the child understands and categorises their experiences by *assimilation* (changing new experiences to fit with their existing cognitive categories or schemas), and by *accommodation*, (adapting existing schema categories to fit the new experience).<sup>12</sup>

## Personal Construct Theory

The subject matter of this book is facet theory, which was originated by Louis Guttman (1916–1987) in a series of articles (see e.g., Guttman 1944, 1954, 1957, 1977, 1979) after the Second World War and during the following decades. It is no accident that at the same time George

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<sup>10</sup>I thank Glen Sizemore for his comments on behaviourism (Sizemore 2014, personal communication).

<sup>11</sup>Within the area of Radical Behaviorism (REF) it has been claimed that human subjects form 'equivalence classes' in which non-reinforced relations between stimuli may emerge.

<sup>12</sup>Piaget is not alone in his conceiving of mental processes as categorical as several other theories originating from different scholars within developmental psychology are based upon a categorical system.

Kelly (1905–1967) was developing Personal Construct Theory (see, Kelly 1991a, b), which was most notably carried forward in the work of Fransella and Bannister (1986). Leading facet theory researcher David Canter (1985) wrote about how Kelly's notion of personal constructs impacted upon the development of facet theory and his own work and indeed in his recent article (Canter 2019) he return to emphasise the connection between facet theory and personal construct psychology. In this book I too propose that the understandings we have of the world around us take the format of personal constructs and that these constructs are evident within the facet theory literature.<sup>13</sup> Indeed, David Canter recognises the importance of PCP in his recent paper (Canter 2019). Thus far, I have fleetingly considered some ways in which a variety of disciplines have portrayed categorisation as being important in how we understanding our daily lives. In the rest of this chapter, I concentrate upon how the academic disciplines of philosophy and neuroscience have viewed categories as related each discipline's conception of human experiences.

## Philosophical Approaches to Categories

The categories that an individual possesses are veridical to that individual, and the categories that members of social groups possess often have pervasive similarities and differences. These two, along with other characteristics, have led to considerable scholarship into categories and have resulted in categories forming an important part of much inquiry into human and non-human animal behaviour and. Philosophers in particular have raised questions about categories in terms of the study of ethics, metaphysics, epistemology and other areas of life. The results of their inquiries have often proved problematic as the explanations they have offered reside at the margins of our knowledge (see, Gorman and Sanford

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<sup>13</sup> Personal constructs are more or less stable dependent upon the environments interaction with the construct. All environments are essentially internal, even if the environment in question is the external location within which a person finds himself or herself.

2004a). In the following section, I provide a selective consideration of some of the major philosophical voices on the subject of categories.<sup>14</sup>

## Cratylus

*Cratylus*,<sup>15</sup> is a dialogue written by Plato's (429–347 B.C.E.) in which he imagines a discussion between Socrates (470/469 BC–399 B.C.E.), Hermogenes (fifth–fourth century B.C.E.) and Cratylus (fifth century B.C.E.). In this text each character personifies and embodies a theory of language in a discussion about the nature of a name. In this thespian dialogue, the character of Socrates sits between the other two characters, each of whom resides at the opposite extremes of this debate. Socrates arbitrates between the first polarised belief that a name is an arbitrary allocation of a word to an event and this position's counterpoint that a name has an intrinsic association with that which it names. Hermogenes states the first position: that words have come to be associated with the event they name solely through convention and tradition of their usage. Cratylus, on the other hand, stands firmly for the second position whereby: names of things and events arrive from divine origins. In this dialogue, the stance taken by Hermogenes leads to the position where a name may be exchanged at will to whatever is wished whilst Cratylus implies a name to indicate a universal and unchanging identity. Socrates' stance is that a word is like a painting in that a 'creator' of words is like an artist selecting appropriate colours of paint in order to capture his vision. The creator of names chooses the most apposite 'sounding' letters that best reflect the nature of that which they name. Indeed, Socrates states that each letter has an onomatopoeic type of relationship to the world and the event it names, phonetically imitating or suggesting the source of

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<sup>14</sup> An interesting collection of essays on categorisation from Aristotle up to contemporary metaphysicians' writing is presented in Haaparanta and Koskinen (2012).

<sup>15</sup> *Cratylus* is the title of a dialogue written by Plato (Plato and Reeve 1998). Cratylus is also the name one of the three characters in Plato's dialogue *Cratylus*.

the sound the word describes rather than a word being a phonetic replications of an event.<sup>16</sup>

The actual content of Plato's dramatic dialogue, and the decision at which it arrives, is not of primary importance in this book. Indeed, the character of Socrates eventually discards language as a focus of his deliberations preferring to examine the events themselves rather than their names.<sup>17</sup> Notwithstanding this, the characters in *Cratylus* demonstrate just how germane to our understanding of the world around us are the categories into which we assign life events (in this case in the example above, the names of things). Events, places, objects, experiences, things, and others., are all known to a person by the word or set of words used to name such instances, perhaps in a manner akin to Hermogenes' claim, "as the instance is experienced" and where the act of naming an event bestows a communicable identity upon this experience. Many centuries later in the nineteenth and early twentieth century, Swiss semiotician and linguist Ferdinand de Saussure, can be seen to continue the debate embodied in Plato's three characters. Central to Saussure's writing about words is that a word is an arbitrary sign, which signifies an object or event, and because words are arbitrary, they only attract meaning from their relationship to other words and what the categorial sign (word) excludes. The consequence of the arbitrariness of words is that words have no systematic relationship to the things they signify and they only possess meaning due to consensual agreement amongst those who speak

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<sup>16</sup> A presentation and discussion of Plato's *Cratylus* is a distraction to the content of this book on facet theory and in which a presentation of Plato's writings is undertaken to illustrate the ubiquity of the human behaviour known as 'category formation' and the naming of these groupings. However, the ideas contained in *sound symbolism* (of which Plato's *Theory of Forms* and *Cratylus* are just one example) provide a great deal of general understanding about linguistic and other categories that are used by humans to structure their daily existences. Aristotle's influence in understanding categories is reviewed by many authors including: Ackrill (1975), Haaparanta and Koskinen (2013), Hood (2004).

<sup>17</sup> In her book, *Gods of the Word: Archetypes in the Consonants*, computer programmer and linguist Margaret Magnusson (2010) posits how a word's form and sound are intimately related to the word's meaning. She claims that letters all have a 'very broad' meaning that is distinct from the meaning possessed by every other letter and that this meaning exists as both iconic and phonetic meaning. The latter of these 'architypally' relates to a consonant's meaning. Letters have meaning and this meaning is infused into each word that contains the letter.

a similar language. Moreover, a word takes meaning through its ability to limit its categorial contents such that a cup is a cup and not a kettle.<sup>18</sup>

## Aristotle

Seminal amongst scholarship on the categorial understanding of being is Aristotle's (384–322 B.C.E.) *Categories* (Aristotle and Ackrill 1975). Aristotle's *Categories* provide a decisive background for understanding his other writing<sup>19</sup> and have also had an important impact upon many philosophers.<sup>20</sup> Aristotle has written extensively upon categories, for instance in his work *de Interpretatione* (Aristotle and Ackrill 1975) in which he proposes a categorial system for understanding such things as the affirmation and negation of propositions. In his book *Praedicamenta*, Aristotle establishes ten categories of linguistically specified experience. It is perhaps no accident that some of the most discussed of Aristotle's concepts are those contained in his brief 15 chapters called the *Categories*.<sup>21</sup> In the *Categories* Aristotle develops a comprehensive itemised catalogue of the types of potential things that may form the subject or predicate of a proposition, that is, everything that can be expressed in a non-composed or structured manner. Aristotle's text allocates all ways in which human beings may understand and be aware of the world within ten mutually exclusive categories which later became known by the Latin name *praedicamenta*. Prior to his formulation of the *praedicamenta*, Aristotle went in depth into providing a necessary background understanding: an *antepraedicamenta*. Here he specifies what various classes of words mean (synonymous or univocal words [words having the same or nearly the

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<sup>18</sup>As I have already noted in the work of Magnusson, some scholars /linguists have claimed a relationship to exist between word and letter sounds and the objects they refer to and Saussure himself identified examples of this.

<sup>19</sup>Including in *Physics* (time, change) *Metaphysics* (being qua being) and *Nicomachean Ethics*.

<sup>20</sup>In the literature it is regularly claimed that those influenced by the *Categories* included: Simplicius (2014), Dexippus, (Dillon 1990), Porphyry (1992); Plotinus; Descartes; Spinoza; Locke; Berkeley; Hume; Brentano and others some of whom I will consider later in more detail.

<sup>21</sup>The '*Categories*' come from Aristotle's works on logic called the '*Organon*' (Cooke et al. 1938) which comprise six parts: *Categories*; *On Interpretation*; *Prior Analytics*; *Posterior Analytics*; *Topics*; *Sophistical Refutations*.

same meaning]; homonymous or equivocal words [words that are imprecise, ambiguous or different in meaning]; paronymous words [words that are derived from another word and has a meaning that is related to this word]); with forms of speech being either simple (single words) or structured (phrases and expressions) with the latter form possessing the exclusive ability to be true or false. Aristotle further distinguishes language that describes the totality of something (this is a car) as being what may be said 'of' a subject from descriptions of a subject that need the subject stated in order to make sense (the colour of the car is white). The latter inheres within the former. He then proceeded to explain the real-world expression of his concepts.<sup>22</sup>

In his *Praedicamenta*, Aristotle defines the ten categories<sup>23</sup> of what he terms 'expressions' or words and phrases to convey an idea within the framework employing the 4 predicate types.

Below I describe these ten categories in a little greater detail. *Substance* is also seen as the essence of something, which cannot be predicated by, or within anything. Aristotle calls these *primary* substances, which define a particular instance of an event (this book or that computer) whereas *secondary* substances denote a general class of events (book, computer). A *quantity* answers the question of how 'much in', both discrete and continuous terms. The notion of *quality* qualifies the character of an event in terms of the characteristics of its descriptors (red, fast). *Relation* identifies the way in which one thing is related to others (faster, slower, cheaper). Two other relative categories are those of *place* and *time*. In the

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<sup>22</sup> Aristotle said that all things that exist possessed the following characteristics: some things state something about a subject but not in any subject (man may state something about Michael or Richard, but is not in Michael or Richard); some things are in a subject but do not state anything about the subject (Michael or Richard may possess knowledge about a subject but, because this is individualistic, this does not state anything about the subject); some things may be in a subject and also state something about a subject (an individual may think about literature and literature may also state something about a book as a subject); some things can neither say anything about a subject and are not contained within the subject (an event is unique and is therefore not either be in the class of a subject or state anything about this subject).

<sup>23</sup> I am presenting Aristotle's Categories to illustrate an early example of the production and use of a categorical system to understand the experience of human life. It is the use of such a system that is of most importance in this book rather than the content of Aristotle's categories. Moreover, 'It is not clear why Aristotle settles for *ten* classes. Aristotle rarely makes use, outside of the *Categories*, of all ten classes; and he was probably not firmly committed to that precise number.' (Barnes 2001, p. 66).

former the event is located in relation to its physical surroundings (in the home, in the office) and in the latter in terms of the course of occurrences (earlier, tomorrow). *Being-in-a-position* may sound as if it is the same as place but here refers to a person's posture or countenance, which he identifies as being the conclusion of a given action (sitting, standing). Being-in-a-position is also used to categorise the 'relative locations' of features of an event. Aristotle defined the category of *having* as resulting from an action upon an object such as being *clothed*. The category has been enlarged to include the trappings associated with an event (the computer's screen). *Action* may also be thought of as the act of producing a change in another object (to type) where this is an active instance. Finally, *affection* is being affected by or subjected to something from some other event. Affection is a passive category where the object in question is acted upon (a charged battery).<sup>24</sup>

Each of the above categories of expressions may be used to signify an attribute of an object. Expanding upon the example of a computer, this may be categorised thus—*substance*: computer; *quantity*: 32 petabyte; *quality*: laptop, *relative*: lighter; *place*: in the office; *time*: now; *being-in-a-position*: sitting on a desk; *having*: has a mouse attached; *action*: processing; *affection*: being dropped.

Aristotle refined his thoughts about categories over many years during which time "Definitions play a central role across Aristotle's work, since they are the primary objects of scientific knowledge." (Koslicki 2010, p. 139). Indeed, Aristotle's work on categories did not end with the *Categories*, but he extended this to consider how things may be thought of as being opposite in nature and through the human senses. Furthermore, Aristotle's 10 categories have been expanded through subsequent research by other academics (see: Hansen 2013). Aristotle and later scholars concerned with metaphysics are interested in the nature of real things or entities. For example, Allan Back's book on Aristotle's Theory of

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<sup>24</sup>Philosopher and theologian from the Middle-ages, John Duns Scotus (1266–1308 C.E.) is another example of a scholar who was influenced by the ten Aristotelian *Categories*. In his category-based ontological metaphysics, Scotus lays emphasis upon the category of substance. The other nine categories, he says, exist in substances. Being a theologian, Scotus, '... makes good use of Aristotelian logical and metaphysical categories. (moreover) ... The category of 'what might exist' is for Scotus, a better frame for understanding divine choices than that of 'what actually exists.' (Ingham and Dreyer 2004).

Predication views his ten categories as ways of being: the ways in which a subject can be said to exist (Back 2000). Another example of this scholarship is provided in the works collected in the book *The Metaphysics of Powers: Their Grounding and their Manifestations* by Anna Marmodoro (2010). Here the editor collects together examples of the diverse contemporary literature associated with the nature of Aristotle's metaphysics of powers and provides an understanding of how the *categories* are driving current scholarly research.<sup>25</sup>

When Aristotle spoke of powers,<sup>26</sup> he was concerned with more than the linguistic description and identification of parts of linguistic expressions but with the nature of our understanding of our worlds.<sup>27</sup> There is an invariant distinction between Aristotle's two types of powers: categorical and dispositional. Moreover, dispositional powers do not arise through the combination of or as a product of categorical powers. The distinction is made between categorical and dispositional powers, where the former are typically inert, and the latter causal. It is important to note here that causation is not being used in a time sequential sense where an earlier occurring event causes a later event to happen. Rather cause is here understood as an intimate relationship between the causal properties of events and the events themselves.<sup>28</sup>

At this point, the question may be asked of how our previous experience is related to Aristotle's categories and powers. For example, in our previous experience, glass breaks when it is struck. As I mentioned when briefly commenting upon behavioural psychology, when we meet a new

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<sup>25</sup> A distinction is drawn between properties and powers and the characteristics of properties and powers within the Aristotelian rubric. Properties are super-ordinate to powers and cannot exist without properties. However, not all properties are powers. Powers are properties like fragility, which predisposes its bearer to behave in a certain way, that is, a glass to break when struck. In this sense, dispositional properties are properties, which cannot be easily or directly sensed but are available for us to causally interact with when they are manifest. That is, we experience the mortality of an animal only when it is in a life-threatening situation and thus manifests its mortality.

<sup>26</sup> See, *The Powers of Aristotle's Soul* by Thomas Kjeller Johansen (2012).

<sup>27</sup> The distinction, though not with reference to Aristotle's writing, between the use of language to represent our experiences will recur throughout this book.

<sup>28</sup> The Greek word for cause seems to imply explanation (Graham 1987) and many several scholars have taken Aristotle's use of the term cause to refer to a process by which he explains. To illustrate this further, Aristotle proposed four causes or explanatory modes: *material*; *formal*; *efficient*; *final* (Loose 2011; Salmon 1998).



and very different instance of glass we are likely to react to this as if it may break if we strike it in a similar manner: we presuppose through generalisation, characteristics or dispositional properties of an event, even though we have not directly experienced this generalised characteristic in association with the specific new event. However, we do not 'know' that the characteristic will generalise, until we are able to causally interact with the new instance (Marmodoro 2014, personal communication). However, having said that personal experience is seen as being of great importance, within this model it does not follow that at least some dispositional properties are creations of our thoughts, memories, and emotions. To wit, I may repeatedly see glass being struck by hard objects and subsequently breaking and from this learn that each of these instances of glass were fragile. In this situation, learning comes about through my, "causally interacting with the manifestation of fragility, which is the glass being broken. Furthermore, after experiencing a glass being struck and broken on multiple occasions I might propose that is a general state of glass to be fragile" (Marmodoro 2014, personal communication). However, it must be understood that the formation of generalisations is a cognitive operation which in itself possesses no causal properties, "Your mental act won't give the future glasses the disposition of being breakable ... you are not creating new dispositions; rather, you are making a prediction about reality, that is that on the basis of what you have observed in the past all glasses might have the same type of disposition, that is fragility" (Marmodoro 2014, personal communication).

Marmodoro (2010) further explores the nature of categories and reviews writers who have identified two forms of properties possessed by sensory events (objects) and which predicate the event, which possess the property towards being perceived as a member of a given category.<sup>29</sup> Marmodoro (2010) notes the debate between metaphysical philosophers as to what type of properties must exist to allow us to understand the manifest, everyday world within which we live. She identifies two types of properties: 1. categorical properties (or qualities) of sensation, 2.

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<sup>29</sup>There may be a possibility to reduce events / stimuli to their fundamental metaphysical and physical properties.

dispositional properties (for Aristotle this meant something like a *causal*<sup>30</sup> power). However, there is disagreement within the literature.<sup>31</sup> Thus, objects that are concrete possess causal powers, and in amongst these, some powers result in objects being perceived to have certain characteristics such as colour, shape, and weight. “Arguably all the properties of a concrete object are reducible to its causal powers” (Marmodoro 2014, personal communication).

## Moses ben Maimonides

Medieval Jewish philosopher, Maimonides (1138–1204) (Halbatal 2013)<sup>32</sup> thought of the Judaic commandments as being categories around which a body of associated details was organised and thus, “To his mind, a commandment is an organizing category of a group of laws” (Halbatal 2013, p. 109). The Maimonides quotation demonstrates how categories have been used as the building blocks of much of our understanding of the world, operating as a descriptive metaphysics and a philosophical description of our actual thoughts about the world in which we live (Moore 2011). Hacker goes further, commenting upon ‘Strawson’s *Metaphysics*’<sup>33</sup> which he says posits that we possess features within our conceptual systems which in part form out of our “nature as self-conscious human beings, involving concepts and categories that we could not abandon without ceasing to be human.” (Hacker 2002, p. 368). Berlin notes the importance of the categories we possess noting how cognitive categories are perceived by some philosophers to be of an entirely different nature where the empirical content may remain constant between observers but the way in which we perceived this reality may vary dependent upon how we conceive and categorise events. To illustrate this point, Berlin states that a person who believes that “God created him (sic) for a

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<sup>30</sup> See my earlier consideration and definition of causality.

<sup>31</sup> Disagreement between monists and dualists and further disputation regarding how any multiplicity of properties may combine.

<sup>32</sup> Moses ben Maimon (Maimonides) has been identified as one of the greatest Jewish medieval philosophers who wrote many texts including the *Mishneh Torah*.

<sup>33</sup> Peter Strawson (1919–2006) was a twentieth century philosopher whose work included *Metaphysics* and *Kant*.

given purpose, believes in the immortal soul and a life after death”, lives in a very different world to the person who does not believe in these things. He illustrates this in reference to the reasons each person chooses a specific course of action, their moral and political codes and their personal relationships. Thus, the categories into which an individual apporions the empirical and conceptual events they experience, the interrelationship between categories and the ways in which a person uses their existential category system to navigate their worlds, will systematically vary between individuals. Furthermore, understanding the arrangement of a person’s category network may go some way in helping us to understand that individual. This point is supported by Canter (1985) when, as part of a background to a discussion about facet theory, he stresses the importance of category formation (in the form of construct systems) as forming the basis of availing humans the ability to function within the world.

As already commented upon, an important feature in category formation is the capability to perceive non-identical events as being similar to each other along given criteria and to allocate events to categories that accord these perceptions of stimuli. Thus, the categories we form are based upon the sensation of the properties of a given event or stimuli, which means that categories exist at both the physical and metaphysical levels. This is an extremely important issue that needs to be kept in mind when working with mapping sentences but is one that is often ignored in favour of assumptions of equality between descriptions and events.

## William of Ockham

In his work *Summa Totius Logicae*, (Ockham 2011) William of Ockham (c1280–c1348) offers an example of a medieval extension in sophistication in his categorical (linguistic) system that has the potential to account for differential perception of similar events and category membership of dissimilar events. Ockham offers the idea of 2 forms of category: *categorematic* and *syncategorematic*. Categorematic categories (linguistic terms) are constituted of fixed categories such as the noun signifiers of, ‘cat’, ‘dog’, ‘enemy’, for example. They are fixed and definite as they categorise

any and all instances of cats, dogs, and enemies. However, syncategorematic categories (linguistic terms such as ‘every’, ‘only’, ‘dangerous’) have no fixed or definite meaning and only find meaning in conjunction with categorematic events. When coupled with a categorematic term the syncategorematic term has a functional relationship with the categorematic event or focuses this in a definite way, for example, ‘every cat’; ‘only dog’; ‘dangerous enemy’ (Ziccardi 2011). The distinction made by Ockham is particularly relevant when we consider the composition of mapping sentences. In my work on declarative mapping sentences (Hackett 2014, 2020) I emphasise the distinction between content facets and the connective ontology of the sentence. These two components of the mapping sentence correspond to Ockham’s *categorematic* and *syncategorematic* forms of category. However, I lay stress upon the interactive nature of the two category forms in determining sentence meaning.

## Immanuel Kant

Immanuel Kant (1724–1804) (Gregor 1997) provides another philosophical view of categorisation. In his writing, Kant addressed categories and category systems, making a move from the concepts that under ran existing scholarship towards a more conceptual or cognitive approach. In his model, Kant identified the *a priori* categories that are needed to enable the cognizance and perception of all possible objects and events (see, Fig. 2.1). For Kant therefore, categories are descriptive. In the Critique of Pure Reason (Kant and Weigelt 2008), Kant forms a list of twelve categories that are based upon all possible judgements that can possibly be made related to empirical events (excluding musings and ruminations). These types of judgements, he says, are objective and refer to general classes of events because of the underlying preconceptions associated with each type of judgement, which form the basis for cognitive understanding. Kant’s twelve categories are broken-down into four sets each of three classes of judgement resulting in twelve pure concepts that humans employ to understand the world (Fig. 2.2).

In Kant’s categorial model, a person makes one of four types of judgement, those which involve quantity, quality, relation, or modality. Within

- 1: Substance (οὐσία)
- 2: Quantity (ποσόν)
- 3: Quality (ποιόν)
- 4: Relation (πρός)
- 5: Place (ποῦ)
- 6: Time (πότε)
- 7: Being-in-a-position (κεῖσθαι)
- 8: Having (ἔχειν)
- 9: Action (ποιεῖν)
- 10: Affection (πάσχειν)

**Fig. 2.1** Aristotle's ten categories (Adapted from: Edghill [2013](#), p. 3)

each of these four categories, three alternative forms of discrimination are possible wherein the combination of these allows Kant to present the categories as an exhaustive list of choices. The categories that Kant specifies are in no way mutually exclusive. Instead, by independently though simultaneously seeking answers to an object's quantity, quality, relation, and modality a total understanding of the object may be obtained. Rather than investigating the nature of the world itself, Kant's categories present a schema of the world, which comes out of asking how a person may make inquiries and thus develop an understanding of the world. Kant's categories are dependent upon the activity of the mind (cognition, memory, perception) and taken together form a set of ontologically descriptive categories.



**Fig. 2.2** Kant's categories. (Translated from Kant and Weigelt 2008, p. 105)

## E. J. Lowe

Kant's form of category system is reflected in the more recent work of the E. J. Lowe (1950–2014) (2007). Lowe produced a *four fundamental ontology system* of categories which developed an understanding that is rooted firmly within metaphysics and which some authorities have linked closely with Aristotle's *Categories*. Lowe's ontology of substantial particulars; non-substantial particulars; substantial universals and non-substantial universals are arranged so as to form two categorially distinct groups which Lowe orthogonally opposes on two linear dimensions which range from the particular to the universal and from the substantial to the non-substantial. Lowe claims his four categories provide an economic ontology that forms a comprehensive metaphysical basis that has the ability to describe, among other things: natural laws; natural necessity; causation and dispositions (Fig. 2.3).<sup>34</sup>

	<i>Substantial</i>	<i>non-substantial</i>
<i>Universals</i>	Non-substantial universals – <i>properties and relations, conceived as universals</i>	Non-substantial particulars - <i>property-instances and relation-instances (non-relational and relational tropes or modes)</i>
<i>Particulars</i>	Substantial particulars - <i>propertied individuals, the paradigm examples of which are persisting, concrete objects</i>	Substantial universals – <i>substantial kinds and include as paradigm examples natural kinds of persisting objects</i>

**Fig. 2.3** Lowe's four-category ontology

<sup>34</sup>The interested reader is guided to Symington (2013) for a much more in depth account of Lowe's work than it is possible to provide here.

It is apparent that linguistic study runs through a considerable amount of the philosophical thought I have discussed thus far. Language, with both its intimate relationship to thought and its structured categorical system, has received considerable attention from those philosophers who have an interest in categories. However, in this slim volume there is not the space to consider in depth linguistic issues in the categorial understanding of the world.<sup>35</sup> Having said this, a succinct illustration of a linguistic approach may be beneficial to my later arguments.<sup>36</sup>

## Gottlob Frege

German scholar, Gottlob Frege, whose work had a seminal influence upon analytical philosophy, adds support to the categorial understandings of reality. For example, in ‘Begriffsschrift’ (Frege 1897), in English ‘concept-script’, he proposed the quantifiable variable and posited the notion that non-linguistic entities are allocated to typological categories in terms of already extant categories of linguistic expression that relate to an entity. Thus, on Frege’s understanding, category differences parallel different forms of linguistic expression (see, Frege and Bynum 2000). Thomasson (2013) makes reference to the work of Dummett (1981), Wright (1983), and Hale (1987) when she cites the example of ‘object’ as being differentiable from other events through reference to the linguistic category of ‘proper name’. She states that “an object is the correlate of a proper name, where proper names are held to include all singular terms (including singular substantive phrases preceded by the definite article)”

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<sup>35</sup> Interested readers are guided to cognitive linguist George Lakoff’s work including: Lakoff (2008).

<sup>36</sup> Michele Prandi forwards the notion of ontological categorisation when looking at the building blocks of human meaning in relation to language. Relevant to my argument in this book, Prandi states that there are two ways in which grammatical structure and formal ontological categorisation have been interpreted. The first of these is that, ‘...the basic formal categories which frame natural ontology depend on the grammatical structures of a given group of languages (...Whorf 1941 ...) or they are universals of human thought ready to surface in linguistic forms (... Wierzbicka 1988, pp. 501–503)’. Michele Prandi (2004, pp. 144–145).



(Thomasson 2013). Thomasson's work is an example of the complex scholarship into the linguistic basis of category formation. Linguistic categorial structures and their usages in forming representations of real-world scenarios are also characteristic of facet theory and this is a subject to which I will return. Another feature of categories both in general and in facet theoretical terms is that categories are not conceived to exist in isolation but to exert a combined influence. The study of the combination of parts (categories) with wholes is the domain of mereology to which I now turn.

## Mereology: Facet Theory and Relationships Between Categories

... one natural and fruitful way of thinking about the structure of the world is that mereology [the relationship of components to wholes] is part of what carves ontology, meaning that one crucial factor that can separate one ontological category from another is that the two categories are governed by different sets of mereological principles.

Markosian (2014, p. 87)

(my parenthetical comment)

It appears from the preceding text (Markosian 2014) that categories, along with the relationship between categories, form the basis of our understanding. However, the question as to how categorial parts relate to, or are assembled into meaningful wholes must be asked. The word mereology comes from the Greek word for part (μερος) and is the study of how parts relate to wholes, theoretical 'part-hood' relations, and the interplay between parts and other parts within a unity. Stanisław Leśniewski (1886–1939) originated the term mereology and wrote upon many aspects of parts and wholes and their associations.<sup>37</sup>

Many of the preceding scholarly examples of systems of categories (e.g., Aristotle, Kant, and others), provide grandiose questions and answers about the metaphysical qualities of existence. Often, their

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<sup>37</sup>A detailed exposition of Leśniewski's mereology may be found in Simons (2000).

accounts employ a hierarchical form of categories, which seems perhaps to be an inevitable emergent structure for understanding part—whole relationships. For example, if we consider that a rose is a flower and it is also a member of every hierarchically higher category above it such as ‘plant’, ‘living thing’, and ‘object’. A car is a vehicle, is a mode of transport, is an object... However, as Gorman and Sanford suggest, this conception of relationships between categories implies there is a highest category level, which may be either unitary or pluralistic (Gorman and Sanford 2004a).<sup>38</sup> The answer to the question of plurality has implications upon how we conceive of reality. Mereology is central to the thesis in this book and later I will present facet theory as a pluralistic ontology, and claim that the use of the mapping sentence’s own specific mereological device a unitary experiential understanding can be developed in regard to the specific content area being considered within the facet theory rubric.

In a longer book, I would have reflected the importance of mereology to my thinking and would have included much more upon this subject. However, having reviewed some of the pertinent philosophical antecedents to the writing in this book I will now turn to another important influence upon my thinking about categories and how these relate to facet theory and mapping sentences, that of neuroscience.

## Neuroscience and Categories

The literature I have presented from philosophy (and other disciplines) has demonstrated the vital function categories play in our lives. Scientific studies have shown that both animals and human beings process and sort the stimuli they gather through their senses into categories (Hernstein and Loveland 1964; Murphy 2002). The literature has also suggested that categories form the basis of scientific and common-sense knowledge (Schutz 1953). The formation of categories from sensed experience is

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<sup>38</sup> The authors continue by noting how Aristotle’s understanding of categories was that these existed at the highest level of understanding and that there were multiple categories at this highest level. They also note the issues associated with the relationships between higher and lower order categories and how such an hierarchical arrange comes about and the consequences of this upon the unity or fragmented nature of reality.

fundamental to how *Homo sapiens*, non-human animals and indeed many other living things, encounter their world. Human beings and some non-human animals are equipped with the ability to synthesise and systematically amalgamate the more elementary conceptual categories of our sensed experiences and to form understandings of greater complexity (Pothos and Wills 2011). Humans represent categories as classes of concepts. These conceptual categories may take many forms from abstract conceptual imaginings, such as thoughts, dreams, and so on, to concrete physical entities such as houses, people, and balls. However, regardless of their type all categories are abstracted from reality in the form of mental representations. Neuroscience attempts to develop knowledge and enhance understanding of the neural processes involved when we categorise perceptual or imaginary events. Neuroscience provides significant understanding about the brain areas and cellular activities associated with categorisation and responses to categories; however, this may not explain the act of categorisation nor why neural activity results in categorial behaviour. Two forms of neuroscience have been at the fore of investigations into category formation and usage, those of *cognitive neuroscience* and *computational neuroscience*.

## Computational Neuroscience

The latter of these two approaches, that of computational neuroscience, investigates how information is processed in terms of the neural functioning of the nervous system's structure, drawing upon knowledge from psychology, developmental psychology (Rakison and Oakes 2002), cognitive science and cognitive psychology (Lamberts and Shanks 1997), computer science, mathematics and category theory (Awodey 2010; Simmons 2013), physics and electrical engineering (Fladeiro 2004). For example, in an article published in *Computational Neuroscience*, Reza Shadmehr and Sandro Mussa-Ivaldi (2012) investigated neural phenomena such as perceptual regularity, sensory stimuli reactions, and movement control. They proposed that perception comprises both a neural model of categories of 'predictions about expected events', which are amalgamated with 'observations of events' in the form of 'beliefs about

the event'. The authors' model is based upon generalised motor control in humans and other animals encompassing an economic effort-reward decision. Computational neuroscience produces both static and dynamic descriptive models of the nervous system and nerve cells in terms of the electro-chemical features of neural systems and structures. As Eliasmith (2005, p. 1036) says when talking about neurosemantic categories, these are based upon "the shared resources of all animals (i.e., neurons)" moreover, studies will, "if suitably constructed, provide solutions to traditional problems in semantics" (original emphasis). In his study, Eliasmith therefore addresses the "theoretical question of how to construct a semantic theory for categories informed by neuroscience". Later, Eliasmith attempts to construct a semantic theory (which is categorial) from neuroscientific understanding. In his, as in other computational neuroscientific research into semantic categories, hypotheses are investigated experimentally by collecting physical and psychological data to test a model for the behaviour under study whilst making reference to neural information processing. Computational neuroscience develops quantitative (mathematic and computational) theoretical descriptive foundations (neural network models) upon which more complex descriptions are developed of normative neural activities and operational principles focusing upon many areas of the lives of human and other animals (Dayan and Abbott 2005). Within these models, normative behaviour may be used as the basis for prediction by employing approaches such as those of Bayesian statistical estimations and multi-dimensional statistical analyses during the course of combining ideal sensory data, observations and existing knowledge (Doya et al. 2011).

Research conducted from within this rubric has noted how humans are able to see and nominally identify several thousand categories of action and discrete objects. The vast number of perceptual events would make it improbable that each event or category of events would be represented in a separately identifiable neural region. Therefore, an alternative neural structure is proposed by Huth et al. (2012) in the form of a continuous semantic cortical surface upon which meaningful categories are smoothly mapped: This, they claim, is a more efficient structure. Huth

and colleagues showed movies to subjects,<sup>39</sup> and measured associated neural activity using functional magnetic resonance imaging (fMRI) and voxel-wise models (as their explicans). Principal components analysis was used and results were projected onto cortical flat-maps, which suggested that sensory events were meaningfully organised into ‘smooth gradients’ across a large proportion of both the visual and non-visual cortex in a way that was common to different individuals. The authors concluded that:

- 1/ The brain represents object and action categories within a continuous semantic space,
  - 2/ This semantic space is organised into broad gradients across the cortical surface,
  - 3/ This semantic space is shared across different individuals
- (Huth et al. 2012, p. 1211)

Cantwell et al. (2017) have described cognitive computational neuroscience as a field that “builds and tests neurobiologically detailed computational models that account for both behavioral and neuroscience data.” (p. 31). In their computational neuroscience study into visual categories, Cantwell et al. (2017) brought two cognitive computational neuroscience models together in order to form a novel “biologically detailed model of perceptual category learning” (Cantwell et al. 2017, p. 31). They brought together the HMAX (Riesenhuber and Poggio 1999) model which was concerned with procedural learning and the COVIS model which is concerned with category learning (Ashby et al. 1998; Ashby and Waldron 1999). To test their novel HMAX/COVIS model they employed bitmap images which they altered and discovered a good fit to human category-learning data when using different forms of visual inputs and category structures. The authors concluded that their model offered an explanation that incorporated neural and behavioural components of basal ganglia-mediated learning.

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<sup>39</sup>The movies contained 1705 object and action categories that they used as explananda.

## Cognitive Neuroscience

In an entirely different manner to that associated with computational neuroscientific research, in cognitive neuroscience mathematical rigour is largely ignored and relatively large neural areas are investigated with neural processes being of secondary consideration. From the findings that have arisen from research in the area of cognitive neuroscience it would appear that the grouping of stimuli (environmental) events into categories is indeed a characteristic of the neural systems in humans and other animals. Neuroscience research has investigated where in the brain and how categorisation occurs, how categories are represented and how items are generalised to categories. Neuroscience research has also investigated how the brain generates new information from category membership. In an early study in this area, Thorpe and Fabre-Thorpe (2001) identified neurons from the prefrontal cortex (PFC) to be responsive in monkeys, which were trained to differentiate (categorise) a variety of animals. Neuroscience research associated with the understanding of category formation and utilisation has been concerned with the neural processing that occurs at the level of both the individual nerve cell and at the level of neural regions. For example, Cromer et al. (2010) investigated whether individual PFC neurons in monkeys were capable of representing multiple or single categories, being generalised or specialised neurons. They found evidence for both forms of cellular activity concluding that cognitive demands were responsible in determining neuron function.

The activity of categorisation is present within neural systems that exclusively feed sensory information in a forward direction. In these circumstances, the brain assigns events and objects to membership of categories, which form the building blocks of knowledge (Cohen and Lefebvre 2005). To date however, the computational neuroscience models that address the formation and use of categories that have been presented do not elucidate the complexities of information processing (visual information) in a way that is meaningful or useful in the understanding of daily activities (Olshausen 2013).

When information gathered from events in our environments is grouped together through the neural function of categorisation,

cognitive neuroscience has asked several questions about this neural function such as where in the brain does this occur, how the brain uses this information and how can new information be derived from category membership? Xiaochuan and Sakagami (2012) have brought together the results from several cognitive neuroscience studies. Their analyses suggest that the answers to these questions are that the prefrontal cortex (PFC) plays a vital role. It appears that neurons from this region are involved in identifying and accumulating common characteristics between individual stimuli. These stimulus characteristic based categories are constructed around semantic commonalities rather than physical features. Furthermore, the boundaries between the categories are formed based upon behaviourally significant aspects present in the data. Xiaochuan and Sakagami (2012) further claim that information relating to category membership together with information about specific properties (such as reward) is simultaneously received by a sub-group of neurons from the PFC region. These neurons are associated with what they call category 'exemplars', which have a dispersed effect among stimuli that are from the same category. This, they claim, may possibly form a neural foundation for the generalisation of a category, located in the PFC. These findings raise interesting questions about the role of the PFC including questions in regard to new knowledge formation from existing knowledge, category generalisation and queries around the area of fuzzy sets (see later in this chapter) and categorisation involving 'fuzzy' boundaries; that is, whether physical or functional features may be more important in category assignment.

The prefrontal cortex therefore appears to play an extremely important role in categorisation and below I provide further examples of research to support this claim. Miller et al. (2011) investigated how different visual objects produced distinct stimulus-evoked sensory responses in the extrastriate visual cortex. They designed a study to view the causal role played by the PFC in evoked responses to images of faces and scenes. They investigated the disruption of PFC function in healthy subjects and stroke patients and found that after perturbation, the extrastriate cortex demonstrated reduced category selectivity to faces and scenes, providing convergent evidence that the prefrontal cortex directly modifies visual sensory data. Other neuroscience research has emphasised that learning

and categorisation are neural activities and have investigated the role of the PFC along with the dorsal striatum claiming both of these interconnected structures to be implicated in category assignment in monkeys (Antzoulatos and Miller 2011).<sup>40</sup>

Agreement exists that the process of categorisation, and various sub-features of the categorisation process, are associated with the PFC in humans and other animals. For example, human behaviour is creative, flexible, and adaptable and fMRI suggest that PFC is an important part of a larger neural network associated with those characteristics. Ann Speed (2010) theorises about PFC function in analogical processing claiming PFC neurons are especially sensitive to information about relationships within experiences. Frontal-striatal circuits in the PFC, she says, drive representation formation and that the real-world consequences (rewards and punishments) of the relationships determine their permanence. Kashimori et al. (2007) note the centrality to cognitive processes of category formation through the meaningful grouping of perceptual stimuli. Their experiments investigated the interaction of the PFC and inferior temporal cortex (ITC) proposing a model of the visual system and visual categorisation. They found the ITC represented features of object parts and categorises objects based upon feature similarities. The PFC plays an integrative role using feature information and feature location in categorisation task related working memory where synaptic connections are learned through PFC–ITC feedback. More specifically, Kashimori et al. employed Sigala and Logothetis' line drawings of faces and demonstrated that the ITC represents face similarity using resolution maps in V1 and V4 and that the PFC generates working memories in which only the information of face features relevant to the categorisation task are held. The learnt and meaningful grouping of complex and combinatorially novel visual stimuli was investigated by Kirsch et al. (2009). They viewed the pigeon's nidopallium caudolaterale (NCL), (an area functionally similar to the mammalian PFC) and how these areas encode visually different stimuli but stimuli that had a similar behavioural relevance, and attempted to understand how learning helped establish

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<sup>40</sup> There are also some disagreements as to how functional magnetic resonance imaging (fMRI) should be used.



categorial representations. Experimental results suggested that initially 'prefrontal' neurons react to stimuli differences within a category whilst coding for rewards associated with a behavioural task. They further discovered that category selectivity strengthened, category specific responses appeared and replaced reward specific responses that extended beyond reinforcement. The PFC is further implicated in stimulus categorisation in the work of Szabo et al. (2006) who hypothesised that selectivity in modulation emerges from the interaction between ITC and other cortical areas, which they posited to be the PFC, where previously learned stimulus categories are encoded. In their model, they proposed that after learning, PFC neurons exerted a top-down effect, which enhanced encoding selectivity in the neurons from the ITC for behaviourally relevant features of stimuli. They further noted how neural areas that are concerned with higher cognitive functioning might interact with, and strongly affect, visually associated areas like the ITC.

During the stage when visual stimuli are categorised Cromer et al. (2011) compared the function of PFC cells with those from the premotor cortex (PMC) discovering that dependent upon circumstance PFC and PMC cells were active and reflected whether test images matched a sample image category. However, whilst PFC cells represented all variables needed to solve a matching problem PMC cells were only implicated in the final decisions that drove motor activity needed to receive a reward. The lateral PFC (LPFC) has been suggested to be active in both learning and processing of categories of visual stimuli. However, in human patients, visual agnosia resulted for specific visual stimuli subsequent to damage to the inferior temporal cortex (ITC) but not the LPFC (Minamimoto et al. 2010). In monkeys, their results strongly suggest that visual categorisation occurred at an early stage, that is, during feed-forward processing, without top-down information from the LPFC. Meyers (2008) looked at groups of neurons and the dynamic pattern coding of activity in the ITC and PFC in macaques. The monkeys performed a task of matching stimuli to categories. Meyer's results demonstrated both ITC and PFC contained information that allowed the monkeys to form abstract relationships between stimuli and categories. They also discovered a difference in the types of information associated with

the ITC and PFC where the former was related to more task-relevant information, and the latter to more detailed visual information.

In a recent article, Ning et al. (2013) used fMRI and discovered that visual information presented to monkeys produced responses in the ITC and especially in the TE (posterior inferotemporal) area, which encoded animate versus inanimate objects. They also found a sub-cluster for faces in the animate region. The researchers concluded that categorisation is hierarchical when progressing anteriorly along the ventral pathway. Along a similar vein and also using monkeys, Swaminathan and Freedman (2012) investigated recognition of category membership for stimuli that had a behavioural relevance. Previous research had shown categorial representation of visual stimuli to exist in areas associated with visual-spatial processing: the PFC along with parietal areas. The PFC has also been investigated in terms of strategy development for new goal directed behaviours and associated reward. Two types of LPFC neurons were observed that displayed reward related activity. One type of neuron predicted reward independently of the physical properties of visual stimuli, and a second type of LPFC neuron encoded the reward value to certain categories of stimuli as specified by task requirements. The authors concluded that prefrontal neurons are able to represent information about rewards based upon stimuli category and promulgate this information to other stimuli from the category that had not yet been directly rewarded (Xiaochuan et al. 2008).

In conclusion, to this section, neuroscience has implicated neural regions in category formation and usage. Computational neuroscience has shown humans are equipped to form complex categories (Pothos and Wills 2011) and studies have developed models of the nervous system and nerve cells. Eliasmith (2005) developed a model for semantic categories and other computational neuroscientific research and has developed predictive models that suggest the nervous systems ability to allow humans to possess thousands of nominal categories. Huth et al. (2012) developed a model that mapped categories onto the neural surface where they claim the brain represents object and action categories and where semantic space is organised on broad gradients across this surface. Kirsch et al. (2009) showed the area analogous to PFC to be implicated in pigeons' category usage.

Cognitive neuroscientific research has also examined category formation and usage. In monkeys, several researchers have found category formation to be associated with: the prefrontal cortex region (for instance, Thorpe and Fabre-Thorpe 2001; Cromer et al. 2010) the inferior temporal cortex has been implicated by Ning et al. (2013) and along with the prefrontal cortex region (Meyers 2008; Minamimoto et al. 2010) showed the ITC to be task related and the PFC to process detailed visual information. Finally, prefrontal cortex has been implicated along with the dorsal striatum in category usage in monkeys. In humans, the prefrontal cortex has been shown to be associated with a variety of category related behaviours (Paniukov and Davis 2018; Xiaochuan Sakagami 2012) with vision (Miller et al. 2011; Szabo et al. 2006) with real world behaviours (Speed 2010) the PFC in combination with the ITC has been related to categories in humans (Kashimori et al. 2007; Swaminathan and Freedman 2012; Xiaochuan and Sakagami 2012) Cromer (2011) found differential roles for the PFC and PMC, whilst Park (2020) found that in primates that prefrontal circuits performed feature to category transformations may be reconfigured as the result of cognitive rules. The examples presented are highly selective and it should be noted that the neural basis of category formation and usage has an extensive literature which has implicated many neural regions and processes and has investigated the relationships between different forms of categories (e.g., Bracci and Op de Beeck 2016; Margalit et al. 2020).

## Conclusions

In this chapter I have considered and presented some of the variety of ways in which a variety of academic disciplines have conducted research into categories and how such disciplines conceive of mental categories. I have noted how philosophy has questioned the human facility to categorise and how the process of categorisation structures our thinking about, and interactions with, the world. I have also shown how neuroscience has provided a clear depiction of intra-cranial structures and activities and how these adapted physiological mechanisms apparently pre-dispose human and other animals to possessing a category-based worldview. A

working understanding and definition of what I mean by the term categories may now be stated to be that categories are a system of genera, which provide a comprehensive inventory of the content of a specific universe. Moreover, the act of categorising I define as a process of elucidating the structure of human conceptual systems rather than assigning aspects of reality to different classifications: This is both my general usage of the term categories and also the sense in which I conceive of the term categories in relation to facet theory. Consequently, veridical and complete networks comprised of ontological classifications are, not a part of the understanding of categories that underlies this book. Instead, particular distinctions among conceptual/linguistic categories embody the understanding I incorporate in this text.

This concludes Chap. 2 and my presentation of a variety of scholarly outlooks on the processes of categorisation. The disciplines selected do not form a comprehensive collection of contributions but rather I have chosen these to show the extent and pervasiveness of thinking about categories. I have also shown that categorical ontologies are pervasive as forms of active and motivated understandings of the parts and whole of our daily lives.

In Chap. 3, I turn to look in detail at one form of mereology, the categorical ontology known as facet theory approach to social research. Facet theory is concerned with the investigation of human experience and with the development of categories (facets) of such experience. These facet divisions of experience are broken-down into sub-categories (elements). The facets and facet elements are denoted and their inter-relationships explicated by assembling facets and facet elements into meaningful wholes by locating them within a mapping sentence. The rest of this book is then about facet theory and the use of the mapping sentence, which is a linguistically based hypothesis of how we understand and experience a life area with which we are concerned. I appraise facet theory in its traditional quantitative format and as a way of amalgamating physical and psychological understandings: joining together when necessary, anthropometrics, sociometrics, psychometrics and other measurement and procedures for gaining an understanding of human experiences and availing

the production of knowledge.<sup>41</sup> I also present and review facet theory as an orientation towards the design and interpretation of qualitative information and the specific form of mapping sentence, the declarative mapping sentence (Hackett 2020), that I have developed for this task.

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<sup>41</sup>After facets, elements and a mapping sentence are specified for an area of human experience, information is gathered to support or refute the facet structure of the mapping sentence. Much of the facet theory research and writing has been about how people categorise their life experiences and how they understand their experiences and how categories vary and are similar between individuals and social groupings.

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# 3

## Facet Theory and Thinking about Human Behaviour

**Abstract** In this chapter, I focus my attention directly upon facet theory and the mapping sentence. The mapping sentence is employed as a template to account for complex behaviour in everyday scenarios. A mapping sentence is used to define the elements of a behavioural vignette. Details are given of the use of the facet theory within research studies that have incorporated the approach. Facet theory is presented as an integrated orientation to research design and analysis. Answers are provided to the questions: what is facet theory; what are facets; what are facet elements; how do facets combined in real life/what is a mapping sentence; what are facet roles; how can facet driven research be analysed?

**Keywords** Human Behaviour • Facet Theory • Mapping Sentence • Facets • Facet Elements

## Introduction

I face a problematic decision between two choices when I attempt to describe facet theory. If I make my first choice, I may choose to explain the overall nature and use of the facet theory approach. By doing this, I hope to make the readers comfortable in their basic understanding of the facet theory approach and the sort of questions this approach to research is able to achieve. My difficulty in adopting such an approach is that in order to describe facet theory in a way that the reader can digest and assimilate I must assume that, to some extent, they already know what several of the important aspects of the theory are. For example, I will have to use terms such as the mapping sentence, facets, and facet elements. My alternative choice in presenting facet theory to the reader who is unfamiliar with this area is to first describe the constituent parts of facet theory (mapping sentences, facets, facet elements, etc.) and then to unite these elements in a later section of my text. The failing with this approach is that facet theory constitutes an approach to depicting the complex interplay of variables and defining parts of the theory before understanding the whole may lead to difficulties appreciating the way in which a synthesis of parts to whole is achieved. Therefore, my approach so far in this book has been a little of both and in this chapter I will interweave both the generals and specifics of the approach to elucidate aspects of my description as appears appropriate. I will however assume that the preceding chapters of this book have been read.

I claimed and demonstrated in the previous chapter that category formation is a rudimentary characteristic and behaviour of both human and non-human animals. I have also shown that the use of categories is a widely present process in many forms of academic activity in the sciences, humanities, social science, philosophy, and many other streams of scholarship. Being so widespread it is hardly surprising that an enormous literature addresses categorisation in some form or another including the academic areas of ontology, mereology, and hylomorphism, all of which are much concerned with categorisation. In this chapter I present facet theory's category forming proclivity both as it exists as a commentary upon metaphysics and as an approach to theoretical and applied

behavioural and social research. I will commence by considering facet theory's knowledge generating capacities.

## Generating Knowledge in Facet Theory: A Brief Overview

Attempting to achieve what seems like an almost impossible task is central to the role of the psychologist: Each day within their work psychologists<sup>1</sup> assail the possibly unachievable quest of comprehending a person's sense of themselves, both as individuals and as members of social groupings. The types of understanding that psychologists attempt to develop usually takes either the form of being either descriptive or measurement based, with both of these approaches being laden with methodological and philosophical strictures and demands (for further details see for example: Howell, 2012; Williams, 2016), where the former of these is narrative-based and the latter numerical. Knowledge generation is often depicted as progressing along a linear path of discovery, starting with a person sensing of events and then observing this in greater detail and forming conjecture about what they are seeing. Then, through the deployment of our rational capabilities and previous analogous experiences, we formulate hypotheses in an attempt to explain what we are seeing. Components of this sensed and conjectured universe are labelled and categorised through a course of interpretative action and semiosis,<sup>2</sup> where such categorial modelling may be related to research issues and to questions that arise from these.

When using a facet theory approach to one's research, data gathering is designed based upon the multivariable hypotheses presented in the mapping sentence (later in this chapter, I consider in some detail, what mapping sentences are and how these are used) and meaning is assigned to

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<sup>1</sup> Here I am, talking about psychologists as attempting to understand the human condition. They are not alone, of course, in making such an attempt. However, whilst acknowledging their non-exclusive possession of such an aim I speak about psychologists as they are the most frequent users of facet theory.

<sup>2</sup> Semiosis is the process of using signs, codes, texts, in producing meaning: see, Bains (2014), and Danesi and Sebeo (2000).



responses through a semantic and reflexive process. These procedures are undertaken with the hope of producing partial answers to research questions. This leads to knowledge development through the information gathered providing insight into the validity of the mapping sentences initial hypotheses.<sup>3</sup> In a somewhat brusque and abstract manner, and without reference to any specific area of research content, the above paragraph provides an overall view of the process of conducting research using a facet theory methodology, although it is important to note that facet theory research invariably utilises a mapping sentence in its design and analysis. In the following sections of this chapter I clarify the components and processes of facet theory and answer the question, what is facet theory?

## What Is Facet Theory?

Over three decades ago, David Canter stated that little was known of facet theory within mainstream social sciences (Canter, 1985). In 2015, as I wrote the first edition of this book, the 15th biennial international facet theory conference was in the process of being organised in New York. Because of the Covid-19 pandemic, this year's meeting has been postponed to 2021, when it will take place in Prague in the Czechia. This will be the 17th international conference. When I attended the first facet theory conference at the university of Surrey in Guildford in 1984, facet theory had been around for 40 years and since then an international community of researchers now uses facet theory. However, whilst the number of users may have increased, facet theory is still little-known outside of those who are its active users. Questions have been asked as to why the popularity of facet theory has not grown more significantly than it has. My answer to this has several components. First, facet theory is an approach to social science research which has been 'discovered' by relatively few. This has led to those using the theory being somewhat of a clique and who have supported one another in their use of the approach. Furthermore, facet theory research is truly

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<sup>3</sup> In quantitative facet theory there are specific programmes for conducting analyses that enable the veracity of the mapping sentence's hypotheses.

inter-disciplinary which has resulted in facet theory being taught in a variety of different academic departments and to its publications appearing in a broad selection of journals and book lists.

Facet Theory is an inquiry method for conceiving of and investigating human behaviour. It is primarily a social science methodology that allows the conceptualization and definition of a research content or domain grounded in the context of its everyday existence. This approach aims to facilitate an applied understanding of the domain—*in totem*. Louis Guttman (1950) emphasised the importance of possessing accurate understandings of the phenomena that we plan to manipulate or observe in order to allow us to gather data for scientific investigation and theory generation, facet theory, he suggested provided such an understanding. Traditionally, in the facet theory literature the approach often employs its own specialised terms and communicates in a highly mathematical way. For example, the word and concept of the structuple are frequently hailed as unique to the approach and one of its major characteristics.<sup>4</sup> The intricacies of the approach allow the differentiation of facet theory from other multi-dimensional analysis procedures, for findings to accumulate and for standardised theory in regard to the content area being investigated to be developed.<sup>5</sup>

A research area that is under facet theory investigation is specified in terms of the research domain's pertinent sub-components, which are called facets and hence the name facet theory: a hypothesis of the pertinent sub-divisions that are important aspects in the experience of the phenomena under investigation. Through this approach, a definition is assembled using facets that are sufficiently encompassing to effectively and expansively represent the whole research domain. The inclusion of a

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<sup>4</sup>We will speak more of structuples later.

<sup>5</sup>Facet theory is especially suited for inquiries into complex multivariate events (Shye 1978, 1981). Analysis of the data arising from mapping sentence driven research involves calculating intercorrelations between observations to empirically test inherent hypotheses predicted in mapping sentences. A range of multidimensional scaling procedures have been developed to enable both reduction in data complexity, (however, facet theory not widely used as a post-hoc data reduction method) hypothesis testing and theory development (through the testing of the expected data structure stated a priori in the mapping sentence's structural hypotheses) (see, Borg 1981; Borg, et al. 2013; duToit et al. 1986; Shepard 1978). It is not the aim of this text to consider data analysis techniques.

facet within a research design is based upon previous research and the investigators experience.<sup>6</sup> Louis Guttman initially developed facet theory, which appeared in a series of articles (1944, 1954, 1957, 1977, 1979). Other researchers (notably for example: Borg 1977; Foa 1958; Canter 1985; Gratch 1973; Hackett 2014; Hackett and Fisher 2019; Runkel and McGrath 1972; Shye 1978) have also produced important texts, which expanded Guttman's notions and brought facet theory to a wider audience.

Louis Guttman attempted to advance a theory with a procedure that was able to establish templates of content domains sufficiently specific to a specific research study to answer the projects applied questions whilst being broad enough to relate to the general content area of the investigation. By possessing the latter feature, a facet template may be formed which can be used to reliably and consistently investigate a given domain in a variety of different real-world contexts. The consistencies present between research investigations that employed a facet design led Guttman to develop 'laws' of human behaviour within these specific areas (attitudes, intelligence; Guttman 1959, 1968) where such laws are embodied in mapping sentences (Hackett 2014, 2020; Lustig and Hackett 2020; Levy 1976).

Indeed, the mapping sentence is at the very heart of facet theory. I will discuss the mapping sentence in greater detail in the following sections but I must here mention that a mapping sentence is, amongst other things, a transparent statement of the facets that have been assembled to be used to design a research investigation. The facet theory approach may differ from many of the theoretical and philosophical understandings of categorical systems that can be used to account for human behaviour and experience (such as those I presented in the second chapter). The unusual aspect of the facet theory approach is that systematic and theoretically stringent empirical observations are made that are designed explicitly to incorporate the facets specified in the inquiry's mapping sentence. By adopting the mapping sentence as a framework for the design of questions, observations

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<sup>6</sup>Facets are empirically valid components of the content area. It is common procedure in psychometric practice to define the relevancy of a behavioural construct through reference to observations in terms of the inter-item association in the content of the measurement items employed.

or as a thematic framework within a qualitative study, the data so gathered is then able to support or refute the facets of the mapping sentence as being appropriate categories of experience for those being investigated in the specific domain that is being studied. In this way, facet theory is able to provide a systematic methodology for the classification of a complex research domain (White and Mitchell 1976). I would go much further than this statement and claim the mapping sentence provides a framework for the hermeneutically consistent interpretation and understanding of the content area it maps (Hackett 2016) I have briefly described the facet theory approach and have mentioned the mapping sentence. I will now consider both of these in greater detail and I will commence by looking at facets and their component parts.

## Facets and Facet Elements

Facets are pertinent and important aspects of a given research area. In a qualitative study that uses facet theory, facets are important areas or bodies of meaning for those who are taking part of the study. When conducting quantitative research, facets are the set of variables that allow the researcher to exhaustively account for the important variation (or as much as possible) observed by the researcher. In both qualitative and quantitative research, facets also make reference to previous research that has been undertaken within a specific research domain. David Canter explains how a central feature of facet theoretical research is the identification of contextually and behaviourally relevant facets, the facets that are most useful in explaining underlying psychological processes germane to a given context Canter (2000) (Canter's area of interest being criminal offenders).

Süb and Beauducel (2004, p. 313) describe a facet thus: 'A facet may be any way of categorizing observations in usually mutually exclusive and exhaustive categories and can be formally described as a set consisting of a finite number of elements'. When asking the question, 'what are facets and what are facet elements?' Canter again offers a useful answer. Facets are, he says, '... comprised of elements which define the different values

**Table 3.1 Important characteristics of facets and facet elements**


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1	Events classified must be categorised using all of the domain facets
2	Each of the facets must be exhaustively broken into a set of values or elements
3	A facet's elements must be mutually exclusive
4	The research must specify the logical interrelations between the content facets
5	The facets specified must together define the domain of the investigation

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that logically and completely describe all of the variations within any facet.' (Canter 1985, p. 22).

In Table 3.1, I provide a list of what David Canter (1985)<sup>7</sup> claims are the five important characteristics of facets and their elements:

Thus, facet elements constitute all of the mutually exclusive sub-values or sub-parts of a facet, as that facet exists within a given context (the facets and facet elements are specifically contextualised within the studies mapping sentence). A researcher is able to be confident that she or he has adequately addressed a research domain through selecting an element from each facet in a mapping sentence to design their research information gathering instruments. If the facets and facet elements meet the criteria in Table 3.1 and research instruments are developed that incorporate all combinations of facet elements, then there can be confidence that the research domain has been thoroughly addressed in the research.

## Structuple

The combination of elements from all of the facets in a study results in what is known as a structuple profile.

I have mentioned mapping sentences extensively but in the section that follows, I will summarise and exemplify the theory behind this device and its use.

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<sup>7</sup>Canter derives his list from Runkel and McGrath's (1972) to whom he credits his list's contents.

## The Mapping Sentence

I have to this point described facet theory in somewhat general terms, including my descriptions of facets and facet elements and indeed, mentioned the mapping sentence. I have stated that facets contain elements that constitute the important aspects of a stated research area. The questions now arise of how can facet theory escape from being a purely theoretical account of a research domain and how do facets and facet elements combined in real life situations? These are fundamental questions that any researcher may ask when they are considering the usefulness of adopting a facet-based approach to their work. The answer to both these questions is through the designing and empirical testing of a mapping sentence. The uniqueness and advantage imparted through the use of a mapping sentence as a template for developing the evaluation of complex situations is due to the mapping sentence's ability to capture the complexity of such situations whilst maintaining a clear designation and sub-categorisation of individual variables within the context of the study. The mapping sentence is the main 'tool' of facet theory research and may be described as:

something like the hypothesis of the existence of a certain specific combinatorial pattern in the way we [each individual] experience a certain sector of reality. Marmodoro (2014, personal communication)

This description of a mapping sentence by Marmodoro is very clearly expressed and is an accurate depiction of the mapping sentence. The mapping sentence has been, and is, used in the manner Marmodoro suggests, to enable the design of inquiries into specific sectors of reality. The mapping sentence provides a theoretical hypothesis of how individual's experience and understands the reality of a given sector of his or her life. The mapping sentence is therefore at the same time both a conceptual and empirical framework that allows the exploration of individuals and comparisons between people without imposing propositions of understanding upon individuals. A mapping sentence specifies the logical relationships amongst facets and facet elements and by so doing, it also assists in the identification of redundancy in facets and

their elements. The mapping sentence also suggests areas where adequate description of research content may be missing.

A mapping sentence is therefore a definitional scheme or framework. The sentence is made of multiple facets and facet elements (as described above), and theoretical understandings about how these variables combine in everyday situations. Two sets of events are explicitly specified in both declarative and traditional mapping sentences: (a) details of the population in the study (the population from which the study's sample is drawn) and (b) the variables that are of interest to the study and the elements of these variables. In traditional mapping sentences, a third set of events are stipulated in the form of (c) an explication of the format and range of the quantitative data that will be collected. The range facet is not included in the declarative mapping sentence in order to avoid binding meaning present in the information collected to being within certain parameters. The above three sets or qualities are enabled as a mapping sentence is designed or adapted to a particular project and suggests both observations and the expected structure of the data that will be collected. The researcher is then able to observe similarities and differences between the expected and gathered data.

I will now demonstrate how the parts of a mapping sentence are assembled by constructing examples of mapping sentences. In each of these illustrations, I will address very different content areas. The first of these is the already referred to mapping sentence for academic dialogue. Following this, I will use a mapping sentence to depict the theoretical content of the aforementioned *Categories* of Aristotle. Finally, I will produce a mapping sentence to account for a piece of narrative text.

## The Composition of Mapping Sentences

During the initial stages of designing a research project, a scholar is faced with the process of generating new tools and procedures (questions, observations) that they may use in their specific study. The researcher wishing to use a facet theory approach in their inquiries will conduct a literature review and discover that either the content area has been previously investigated using facet theory or it has not. When the research is

into a subject area that has not previously been investigated using facet theory, the initial research activity is the development of a new mapping sentence to address the content area.

### **Traditional Mapping Sentence for Academic Exchange**

I have already presented in Fig. 1.1 a mapping sentence that I produced to account for a dialogue with a colleague I had about philosophy in general and Aristotle's ten Categories specifically. I developed this mapping sentence by reading through my email correspondence and highlighting what appeared to be the important aspects of our conversation. I identified whether each of the highlighted words or phrases appeared to subsume another highlighted word or phrase or was itself subsumed within a highlighted word or category. In this manner, I identified the facets (subsuming categories) and facet elements (items that were subsumed). I then put the facets into a sentence format that presented each facet and its elements in a logical manner. Putting the facets into a sentence meant that I stated how I believed the facets related to each other and I therefore connected the facets using everyday language. The connective phrases and words can be thought of as functors or as a connective ontology. These parts of a mapping sentence are of cardinal importance as they determine the meaning and the types of relationships between facets. They are also very frequently ignored in the facet theory literature, or may not even be present in some reductionist mapping sentences. I carefully chose the facets, elements, and connective phraseology and brought these together in a way that suggested how the facets actually structured my understanding of our conversations. The resulting initial mapping sentence is shown in Fig. 1.1.

### **Traditional mapping sentence for Aristotle's Categories**

I now provide another example of a mapping sentence that has been designed to allow exploration of a domain that is novel to facet theory



research. In Fig. 2.1, I listed Aristotle's *Categories* and below in Fig. 3.1, I incorporate these *Categories* into an initial mapping sentence. I am here presenting Aristotle's *Categories* in a very superficial manner. Both Aristotle and the many commentaries on his work display a great complexity that the initial mapping sentence I have produced does not attempt to capture. A simple example of this is provided in Thomas Aquinas' (1225–1274 C.E.) commentaries on Aristotle's understanding of the senses (Aquinas et al. 2005). Here Aquinas says, for example, that when Aristotle thought of colour he differentiated between things that are coloured of themselves 'intrinsically' and things that are transparent or coloured from without, thus he concluded that colour is the limit of transparency: "Thus color is not a category of quantity—like surface, which is a limit of a body—but in the category of quality" (Aquinas et al. 2005, p. 60). Moreover, Aquinas notes how Aristotle's limiting of the transparent by colour is not opposed to his claim that colour is of itself and will be meaning and limiting this to things that are themselves coloured. If the initial mapping sentence was indeed to be used to guide an actual research project into Aristotle's *Categories* then considerably greater time would be invested into developing an initial mapping sentence that more adequately reflected Aristotle's work and commentaries upon this. The initial mapping sentence is a beginning or preliminary instantiation of an exploratory understanding of the *Categories*.

Notwithstanding the above remarks, my first task in designing a mapping sentence that describes the variability in the content of Aristotle's *Categories* involved me reading through Aristotle's text in which he describes the ten categories (many translations and interpretations of this text exist, see for example: Edghill 2013; Frede 1987; Sim 2004).<sup>8</sup> In doing this I was able to identify the ten categories, which I wrote as headings. I then read the *Categories* text along with several commentaries upon this and identified the range over which Aristotle appeared to specify each category may exist or exert an influence. This took some time but eventually this resulted in ten categories each with what I propose are appropriate sub-divisions: these formed the facets and facet elements respectively. I then arranged the facets and linked these with connective

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<sup>8</sup> There is a vast literature on the *Categories* and I simultaneously consulted part of this canon.

**substance**

person ( $x$ ) perceives the given {*primary* } substance,

{*secondary* }

**quantity**

in terms of its, {*continuous*} quantity, and its,

{*discrete* }

**quality**

{*habitual and dispositional* } quality, which may be in either,

{*natural capabilities and incapacities*}

{*affections and affective* }

{*shape* }

**relation**

{*isolated* } relation, in a given,

{*interacting*}

**place**

{*near to* } relative location,

{*far from*}

**Fig. 3.1** Initial mapping sentence for Aristotle's ten categories of being

**time**

**having**

and, {past } time relative to extrinsic events, whilst having, {their clothes}

{present}

{ornaments }

{future }

{possessions }

**action**

whilst the action of the power a substance, {upon something else} is associated with,

{within itself }

**being in**

**a position**

**affection**

{positive } change, and being the recipient of a given, affection, {upon the self}

{negative}

**range**

by which they understand their being from a, {higher}

{ to } extent.

{lower }

Fig. 3.1 (continued)

language in accordance with Aristotle's text to conform to linguistic logic. I actually produced several initial mapping sentences but due to limitation of space, I present just one example here. I chose to include this particular version, as I believe it to form a useful template that may guide future inquiry.

### **Traditional Mapping Sentence for Understanding the 'Mise-en-Scène' of a Narrative Text**

After having looked at the first two mapping sentences, I hope that it is now becoming apparent how all mapping sentences embody several features: structural hypotheses, and essentially conjectures about the important variables or aspects (facets); levels of these variables or aspects (facet elements); a specification of the roles of facets; a suggestion as to how facets and facet elements may be combined in an investigation in order to allow for the development of greater understanding of a domain. As well as structuring the design of a research project, mapping sentences are structural in a further sense. In traditional quantitative facet theory, this structure is revealed in multidimensional statistical analyses of data collected using instruments developed with mapping sentence as a template. Using these analyses graphical structure is revealed which demonstrates the similarities in the data set and provides or rejects the hypotheses used in the design of the study's mapping sentence. In qualitative facet theory using a declarative mapping sentence without a range facet, the information that is gathered from a study is subjected to content analysis, thematic analysis, etc., in order to test the mapping sentence's proposed structure.

David Canter comments upon the role of an initial mapping sentence and how the sentence's status as being initial may change after research guided by the sentence has been conducted. Canter notes how a mapping sentence is the initial stage of a research project and it is also frequently its conclusion (Canter 1985). The above mapping sentence for Aristotle's *Categories*, attempts to offer a structural configuration to what is obviously an extremely theoretical research domain. However, most often mapping sentences are developed for more everyday human behaviours

and experiences. To illustrate one way in which a mapping sentence may be originated to account for more complex human (perhaps empirical) events in a setting that is more reminiscent of everyday social life, below I have written a brief, fictitious vignette, a literary account of everyday life, a reflection of a personal experience of an individual.

## Narrative

She was old now, of advanced enough an age that the man next to her, her son, was himself old enough to remember exactly where he had been when he heard that JFK had been shot. The woman was contemplating the room and the house. He was also thinking about the house, the kitchen within which they sat, the wooden chairs. Were those chairs always where they now stood? Green, scraped, they too possessed a history, contemporary with the chills of Soviet relations. The chairs and table perceived by mother and son, all possessed their own story; conflicting and harmonious narratives. He tried to remember where the table stood when he was a child. Did his mother always sit under the window with its erratically painted mullions and transoms? Two windows and a single light bulb in a yellowed-glass pendant provided light over the table. She remembered buying the table and chairs in a yard sale; he still felt the pain of falling from its elevated surface that warm Sunday afternoon. The kitchen had two doors facing each other: one led to his childhood friend who lived in the next house and who called to see him early each Saturday; the day when they would run down the streets screaming a confirmation of their freedom. The other portal from this semi-public space with its verdant tableau took them both into those undisclosed areas where she was in command; his existence beyond this door was not confirmed by yelps of joy.

They both sat and reflected upon the table and chairs and the objects set upon the varnished dining surface. Of these items, some were functional and only appeared with each meal, the vase was less transient in its presence. She questioned whether the room had always been this size, so small with dim recesses at its corners. How had they lived here all those years? She remembered cigarette smoke that was inevitably worn by all

present, coddling their shared stories. The man's eyes still smarted at the memory of the gaseous wrapping that excluded him from the adult conversation with its controlling intent.

The day at work had been hard for him followed by a slushy walk through the snow to see his mother; through cold damp streets and an empty grey sky that paralleled human absence; his feet numb from the cold. She remembered the frequent visitors who used to come and knock on the door, joining them, sharing cups of coffee or glasses of lemonade; the choice predicted by seasonal divergence. They both saw the others, clustered around the table, sitting, standing in sombre reflection and blithe coterie. He remembered the men, for they were nearly always men, in long winter coats or in shorts and 'T's'. She felt the ease of mutual happiness and shared worries, a table and chairs in a kitchen, in uncertain places and at indecisive angles. The *mise en scène* of their shared lives, faded into the monochrome, an Expressionist movie evoking Dr Calligari, an abstract Cabinet that had differing content for mother and son. A home for their personal recordings of the circumstances and the facts and beliefs within which they lived and through which they understood their lives.

When we read the above narrative, we develop our own informal appreciation of its content, a mereology constituted by allocating the parts of the story to different, qualitatively distinct components of our understanding of the meaning of the whole narrative account. By this, I mean that parts of the narrative are understood as discrete entities by a given individual and these parts will have different relevance to all readers. Directly below is an initial mapping sentence I have developed to help to illuminate understanding of the important components of the 'Narrative's *Mise-en-Scène*'. I am here using the term '*Miser-en-Scène*' as this is a theatrical term that means the surroundings of an event, the stage settings, for example, and this captures the essence of what this initial mapping sentence that I have formulated portrays.

I developed the above mapping sentence by first reading through the narrative several times and making notes/highlighting words and phrases that appeared to be of particular importance to the content of the story being told. I then listed the words and phrases I suspected to be pivotal in the narrative's understanding. I attempted to identify any relationships

between these in order to suggest how these words related to each other in terms of the narrative's flow of meaning. I also made an initial decision as to which of the highlighted words/phrases appeared to be facets (major meaningful sub-divisions) and which may have been facet elements (items that appeared to be subsumed within the experiential category of a facet).

To illustrate what this procedure achieves, in the mapping sentence for the 'Mise-en-Scène' of Narrative', facet C defines the respondent pertinent area of their abode or home. The important sub-aspects of experience within the home are the house itself, the kitchen, other rooms, and outside of the house, which are the abode facet's elements. The important point here is that if I had attempted to account for the experiences of individuals in the narrative without an explicitly labelled abode facet, a valuable part of my personal understanding would have been omitted. Moreover, if I had included abode as part of my enquiries but had either left this as a holistic concept, or had divided it say into, 'public rooms' and 'private rooms', this structure would have imposed a form of understanding not present in narrative. I then proceeded to order the facets in a meaningful manner as they related to the content of the narrative and to connect the facets and their elements using simple English phraseology. I repeated all of these stages several times which took some time and resulted in several attempts and deletions of these. I continued doing this until I felt confident that the resulting mapping sentence was an adequate initial representation of the experiential variables (facets) that the fictional narrator used to structure his understanding of the narrative's content. As a final check of the mapping sentence I had constructed I asked colleagues for their comments.

In three of examples that I have provided above all of the mapping sentences were traditional mapping sentences in which each clearly focused upon assessing understanding of the content they embodied in terms of a single outcome variable. These outcome variables were stated in the range facets for each study and were: (academic exchange) a variable that measured the degree to which a person understood an exchange to have been of *greater to lesser a success* in terms of their intention within the specific dialogue; the extent from a *higher to lesser*, to which a person

was able to understand what constituted “being”; functionality rated from *positive* to negative in terms of their place experiences.

## Initial Declarative Mapping Sentence for Musical Preference

The three mapping sentences above are all traditional and I now provide examples of declarative mapping sentences. The declarative mapping sentence is similar to the traditional mapping sentence in that you read through the sentence multiple times and each time you slightly change your reading. You do this by selecting a different element from each facet on each reading. These combinations of elements within the declarative sentence are undertaken so as to either comprehensively embody all possible combinations, or if there are a large number of possible combinations then this is done systematically. After establishing a map of structures that are to be incorporated in the research device, questions, observations or other research instruments are then designed to correspond with these structures. Through taking this approach, the entirety of the content domain is addressed.

The first Declarative Mapping Sentence I provide as an example is for Musical preference. In this mapping sentence, Lustig and Hackett (2020) developed a declarative statement to account for musical choice. To do this they incorporated the facets that were necessary to understand the important components of these choices in the real world.

In their mapping sentence Lustig and Hackett (2020) the facets that they chose were: (1) musical genre; (2) the era or age from which the music came; (3) the access media. The authors stated that they positioned the genre facet first as this was a more general facet which set the stage of the mapping sentence which followed. They describe how they constructed the mapping sentence and listed a stage-wise progression from adding one facet and then another. They started the sentence thus:

*Music listener (X), prefers music from the:*

**Genre**

- *Vocal*
- *instrumental genre*



In all mapping sentences, it is the element that becomes part of a reading of a mapping sentence and is what is used to design research instruments and to interpret the research findings. In this example, the facet is of genre with the elements of vocal and instrumental, for example:

*Music listener (x), prefers music from the instrumental genre*

The next facet that the authors incorporated was of musical era and they connected this to the genre facet with the following words:

*that originated from the:*

The second facet they chose was the era or age the music came from as this, the authors believed, was an important aspect that differentiated musical preference. The facet of era/age was stated with the following elements:

***Age/Era*** (*what era the music originated from*)

- *18th century (1701–1800)*
- *19th century (1801–1900)*
- *20th century (1901–2000)*
- *21st century (2001–present)*

*era,*

Lustig and Hackett then connect these two facets to a third facet that they called media of access. They said that this facet was included because in discussion with music listeners this facet was mentioned as being an important influence upon their choices of music. They chose the following words to represent how they believed access media related to the previous 2 facets:

*which they access in the media form of:*

They included the following elements in the facet:

*Access media (how the music is accessed)*

- Streaming service
- Digital download
- CD
- Vinyl
- tape

Taken together, (see Fig. 3.3 for the completed mapping sentence) the authors stated that they believed that the chosen facets, elements, and the connective phraseology they chose to join the facets together depicted how musical choices were made in a real world situation.

### Initial Declarative Mapping Sentence for Evaluating Study Space for Optimal Productivity

The next example I provide of a declarative mapping sentence is another one from Lustig and Hackett (2020). In this mapping sentence, the authors were interested in attempting to identify for investigation the aspects of a place that were related to how optimal this was as a place in which to study. This resulted in the declarative mapping sentence in Fig. 3.4.

In this illustration, the authors again decided to develop a declarative mapping sentence and to not include a range facet that would have restricted their concern to being with a single quantitative outcome measure of space performance. They identified their domain of interest as being the aspects of space that influenced the ideal space in which to study. The facets that they included in their mapping sentence were lighting, temperature, and organization. As I went into detail about how the mapping sentence was constructed with my last example, I will not repeat this level of detail here. However, in Fig. 3.4, it can be seen that words and phrases were placed between the facets to make a declarative mapping sentence. Again, elements from each of the facets can be selected on any reading through of the mapping sentence which, for example, can be read as:

person X experiences space in terms of the lighting and temperature as well as how it is organised to yield an ideal space conducive for optimal productivity.

The selection of elements focuses a sentence upon specific aspects of the research domain that is of interest (space in terms of its influence on studying) whilst the connective words and phrases between the facets provide precise meaning within the sentence. If a researcher changes either the elements or the connective phraseology, they will alter the meaning of the sentence and consequently they will change the meaning of the research. It should be remembered that changing the connective words can have a profound effect upon the meaning of the sentence even though the facets and elements may have been kept constant.

## Summary of Mapping Sentences

In the mapping sentences, I have presented of Aristotle's *Categories* (Fig. 3.1), the *narrative's mise-en-scène* (Fig. 3.2) and the *academic dialogue* (Fig. 1.1), *musical preference* (Fig. 3.3) and *space evaluation* (Fig. 3.4), none of these content domains have previously been explored using facet theory and this necessitated the designing of *initial* (untested) mapping sentences prior to study commencement. However, the facet theory literature has been growing over the preceding decades, which means that a wide range of content domains have been, at least initially, explored using facet theory. In these cases, the researcher does not need to develop an initial mapping but is able to incorporate a mapping sentence that has been employed to explore their content of interest. A facet study gathers and analyses information to allow necessary modification of its mapping sentence. In this situation, an existing mapping sentence with a structure that has already been investigated may be used not just for theory generation but also for theory extension.

When there is an extant mapping, a researcher may ask the question: "what utility exists in incorporating an existing mapping sentence into their inquiries?" The answer to this is manifold and includes: the ability to ask questions in a similar manner to previous research whilst being able

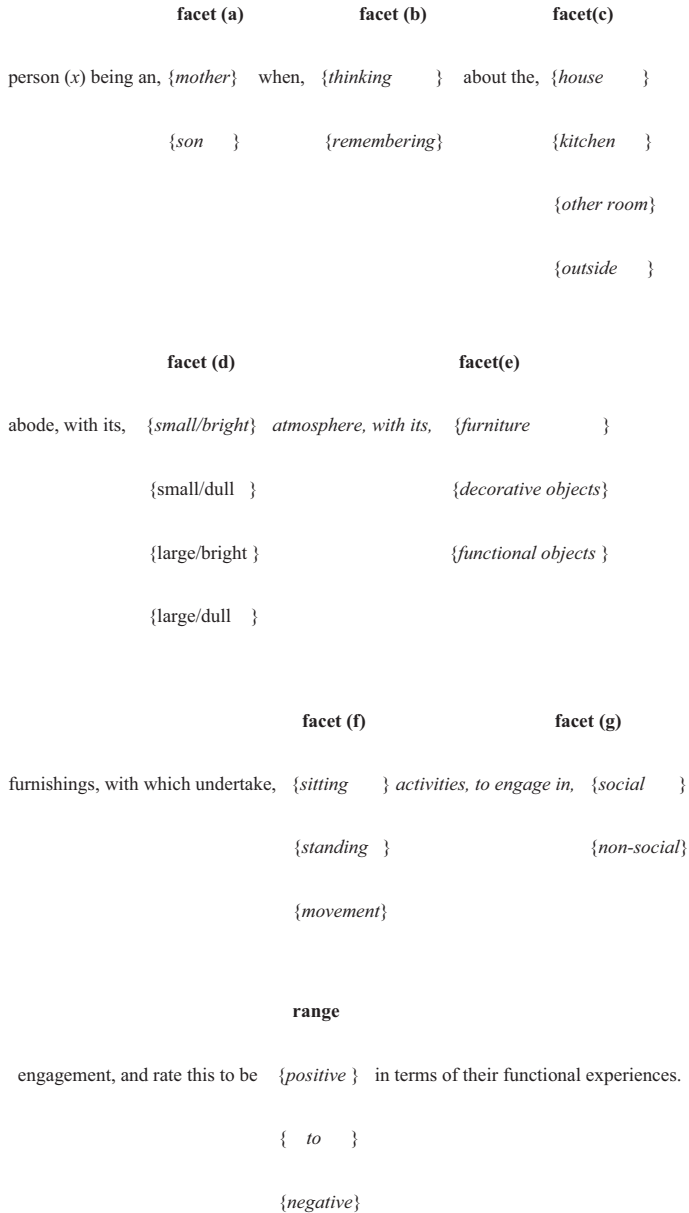


Fig. 3.2 Initial traditional mapping sentence for the 'Mise-en-Scène' of narrative

Music listener (X), prefers music from the:

**Genre - A**

(1. Vocal )

(2. Instrumental )

genre, that originated from the:

**Age/Era - B**

(1. 18th century (1701- 1800) )

(2. 19th century (1801- 1900) )

(3. 20th century (1901-2000) )

(4. 21st century (2001-present) )

era, which they access in the media form of:

**Access media – C (how the music is accessed)**

(1. Streaming service )

(2. Digital download )

(3. CD )

(4. Vinyl )

(5. Tape )

**Fig. 3.3** Declarative Mapping Sentence for Musical preference #1 (Lustig and Hackett 2020)

Person X is interested in understanding space in terms of studying by evaluating:

**Lighting**

(too bright )

(to )

(too dark )

for optimal sight, and feeling:

**Temperature**

(too hot )

(to )

(too cold )

in addition to:

**Organisation (Cleanliness)**

(too organised )

(to )

(too messy )

in terms of this yielding an ideal space conducive for an optimal productive study session

**Fig. 3.4** Declarative mapping sentence for evaluating study space for optimal productivity (Lustig and Hackett 2020)

to tailor these to a specific situation; for the findings from the new study to directly relate to existing findings; for differences and similarities between previous and new research to be directly compared and for these to be clearly attributed to context rather than variation in research design. A consequence of not utilizing a common research design may be that findings from different studies have little in common and are non-comparable. This situation is analogous to one research study being conducted into the qualities and usability of 'Mac' computers, another study investigating 'Microsoft' computers and yet another study investigating 'Dell' computers (the actual computer brands are irrelevant). However, if the research studies were conducted independently with no explicit or common definitional understanding of 'what a computer is and how it is used' then the results from the three studies will be a series of snap-shots which are unlikely to lead to the development of an overall understanding of computers and their usage. Any similarities in results, or the ability to confidently state why any differences or similarities were observed between the separate research studies, would occur by chance. Moreover, any understanding of the overall concept and usage of a computer based solely upon these results would tend to be fragmented and disorganised. However, research using a mapping sentence has the unequivocal potential to develop a body of cumulative knowledge.

It seems reasonable to claim that we usually experience our own lives as integrated wholes, or as sub-divisions of this whole which in themselves form meaningful experience. Therefore, any attempt to account for human behaviour needs to provide for the integration of behavioural and experiential elements. When taken together, the facets in a mapping sentence provide a combined account for a life area. However, individually facets can have different formats or structure reflecting the various different types of behaviour a facet represents. In the following section, I describe some of these facet structures, which may be thought of as the roles a facet plays. Speaking generically, by combining pertinent variables the initial mapping sentence attempts to explain or illuminate a specific area of behaviour or experience. However, a thorough account of a research domain must identify the ways in which different types of facets affect our lives and must account for the specific ways different facets are understood. To illustrate what I mean we may consider how we

understand the experience of seeing an animal walking down the street be using several different evaluative facets. We may identify the animal to be a dog and not a cat or fox, where *animal* is a categorical facet and also to be medium sized, where *size* is a scaled facet. The former is an all or none understanding, the creature either is or is not a dog, whilst the second evaluation is one of extent, i.e., small, medium, and large. To complicate the situation we may also judge the dog to be important to our experience (for example, the dog is our dog and we are attempting to walk with the dog) or not so important (the dog is a small stray dog on the opposite side of the road, walking away from us). In this simple example I have identified three pertinent facets (species, size, importance) and suggested facet elements for each (respectively: dog, cat, fox; small, medium, large; central importance, peripheral importance). There are many other facets of the experience but for this example, let us concentrate on these three. A declarative mapping sentence could be written to describe this event in the following way:

Person (me) sees the (small, ~~medium~~, large) *size* (dog, cat, fox) *species*, which in the present context is of (~~central importance~~, peripheral importance) *relevance* to me.

I can also add a range of the behaviour that I am interested in investigating in terms of the combined effects of the three facets. In this example, I have chosen approach behaviour as my approach willingness is influenced by the state of the three facets' elements in combination. The resulting traditional mapping sentence would then read:

Person (me) sees the (small, ~~medium~~, large) *size* (dog, cat, fox) *species*, which in the present context is of (~~central importance~~, peripheral importance) *relevance* to my encounter with the animal, that I *approach* to a lesser to greater extent.

Finally, in this example, it is important to note that the *size* facet is quantitative and measures understanding along a linear dimension of greater or lesser (small to large), the *relevance* facet is also quantitative but has its effect on our understanding of the animal by focusing



judgments through interacting with the *species* facet, whilst the *species* facet involves a qualitative assignment (the *species* and *relevance* facet interact as I own a dog but not a cat or fox and therefore, in my attempts to identify the animal, only a dog species can be of central importance and other species of animals would have been judged to be of more peripheral import). This example has resorted to using the mapping sentence to illustrate three of the different types of roles variables may play when they are depicted within facet theory. In the following sections, I will further explore these roles.

## Roles That Facets Play

Facets are descriptors that may be used to describe a wide and varied array of personal experience and actions. Above, in the examples of mapping sentence that I have provided, I have highlighted just three of the most elementary facet roles or structures. There are other roles that facets may play in structuring experiences both on their own and together in double and treble facet structures. Paul Kline notes how Louis Guttman developed facet theory and identified facet roles in his seminal works on the subject and that Guttman's facet roles "are known as the simplex, the radex and the circumplex. These are based on the rank ordering of correlations." (Kline 2000, p. 87). It should be noted that the formal definition and identification of facet roles has been a component of quantitative facet theory which arise from the analysis of quantitative data and the traditional mapping sentence. However, the roles are not exclusive to quantitative research and have been used to depict the nature of facets in qualitative research. It is interesting to note that the facet roles have even been used by me in a counselling situation where the roles of facets were used to offer insight to a client about their issues (Hackett 2019). I now present some of these facet roles.

## Single Facet Structures<sup>9</sup>

Perhaps, the simplest form of an overt or covert human behaviour is one that may be understood using a single facet (most clearly described above in the size facets). Some of the constructs (facets) that we use to make sense of our world operate in isolation and I will turn to these first.

### Axial Role

Axial facets represent relatively independent forms of understanding that are not directly affected by or directly affect other facets associated with the content of interest. When they are present in the geometric output plots that result from quantitative facet theory research, axial facets cause plots of content items to be divided into distinct parallel strips or regions (the spatial representation of facets will be considered in greater depth later in this section of the chapter). In an axial facet, events are assessed or understood to possess more or less of a given entity, quality or construct and to form a simple approximation to linearity. The order of facet elements in an ordered facet are derived from the rankings of correlation between event pairs and the geometric arrangement of events is based upon their non-metric inter-correlation. Consequently, items that are close to each other in terms of this linearity are perceived as being more similar in reference to this construct whilst those further apart are more dissimilar. This arrangement is termed a simplex and may be predicted if the basis for ordering is known at the design stage of the research. In the example of the *size* of animal facet, it seems reasonable to predict that the size facet will be structured from small to large, but this arrangement may often be more idiosyncratic and less apparent.

It is important to note that the partitioning of an axial facet may result in partitioned segments that are in a different orientation to the vertical arrangement given in Fig. 3.5.

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<sup>9</sup>Dancer's (1990) provides a comprehensive commentary upon facet structure and roles to which I refer during this section.

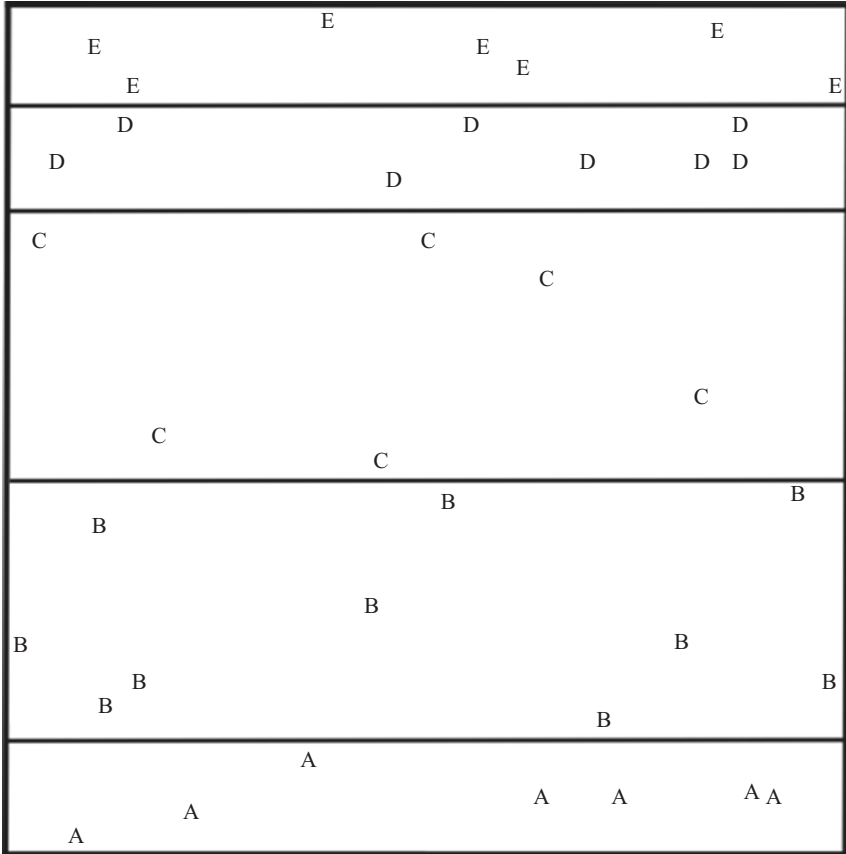


Fig. 3.5 Axial facet

**Radial Facet (Modular Role)**

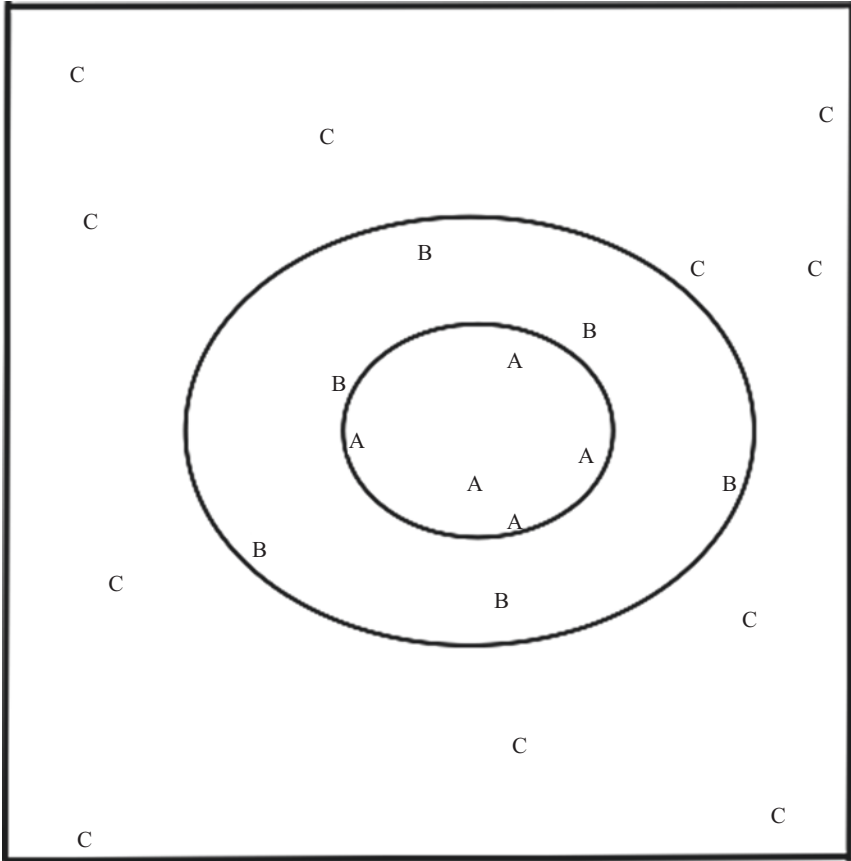
A second type of facet that employs a single facet to structure a person’s understanding of a content area, sometimes independently of the effects of other facets, is a construct called a radial facet that plays a modular role. Here, the understanding embodied in a modular facet will cause events to be seen as more or less related to all other events in terms of a specific construct but not in a linear sense: some items will be general and others more particular in reference to the construct. This form of

psychological process will result in some events being placed centrally whilst other events are located progressively more peripheral as they become less related to other events as understood through the construct. Modular role facets are depicted as concentric rings that emanate from a central point.

The events most highly inter-correlated with other events, when embodied in a modular facet, will fall towards the centre of this geometric space with progressively less inter-related events positioned towards the edges of the space. Adjacent events that are a similar distance from the origin, regardless of where they are otherwise positioned in geometric space, will be equally associated to the facet's construct. In the example of animals, because of their personal relevance, all dogs may be seen to be understood as more similar in terms of their personal relevance, whilst other species will occupy progressively more peripheral and perhaps isolated locations away from the projection's origin. It should be remembered here that it not the species of the animal that is associated with the animals classification on this facet but the importance of a given animal to the person making the evaluations. As this person typically had dogs as pets, the dogs are more important and the notion of species will act as a proxy measure for importance. However, should the person have at one time in their lives been regularly visited by a fox, this creature would also tend to be centrally located in their understanding.

### **Modular Facet (Angular or Polar Role)**

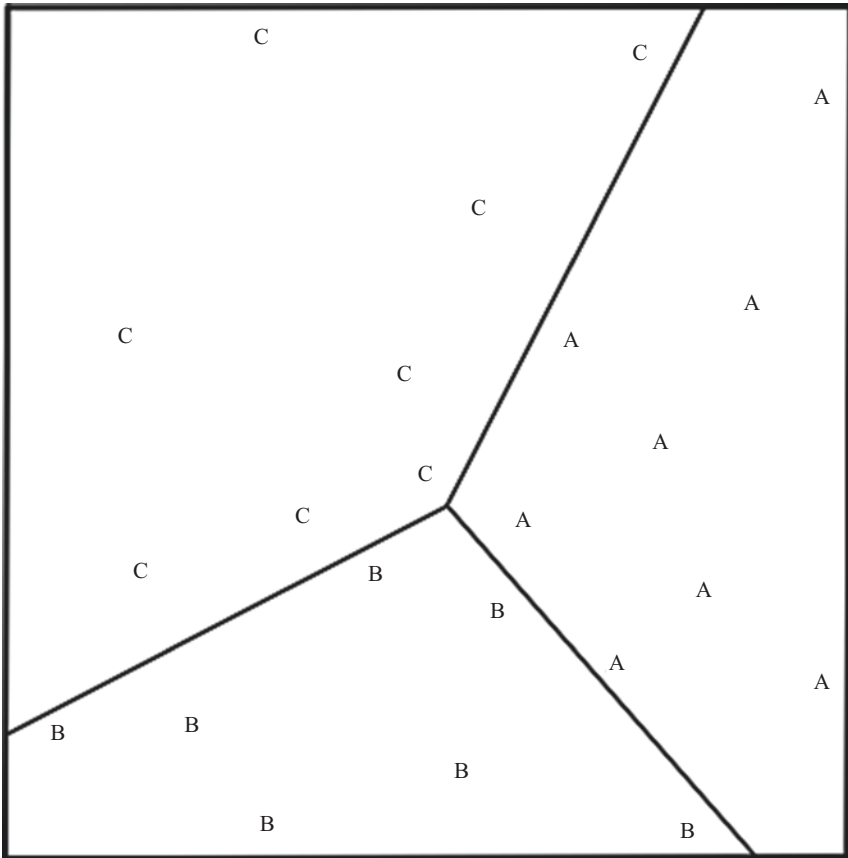
A third role that may be played by a single facet is the polar role of the modular facet. This role results in events being qualitatively differentiated in terms of the facet's content. Events evaluated within a modular facet are understood to have no inherent ordering and are arranged geometrically as wedge shaped sections with a common origin. This is a qualitative arrangement with no ranking between regions. Another characteristic of a modular facet is that due to the lack of ordering present it may be the case that no prior hypothesis may exist for the arrangement of facet elements. However, adjacent elements will be perceived as more similar than those more distantly positioned from each other. In the



**Fig. 3.6** Radial facet (modular role)

animal example, a modular facet arranges the specific species of animal. Dogs, cats, mice, fish, birds, and foxes are not ordered in any terms but rather they are simply distinct from each other and will tend to occupy distinct regions.

It should be obvious to the reader that the facets I have described, whilst being relatively independent in their effects are not completely isolated. Good examples of this are the facets of species and importance, which are inter-associated. I will return to this when discussing the radex facet structure (Fig. 3.7).



**Fig. 3.7** Modular facet (angular or polar role)

### Circumplex

The final single facet role that I will consider is the circumplex, which is described by Brown (1985) as a being represented as a circle. This structure must be differentiated from the modular facet's centrally originating wedges that also has a circular arrangement. Distinct from the modular facet, the circumplex structure embodies qualitative linear differentiations between events where there is an ordering present but without a beginning or end (Lorr and McNair [1963] cited in Brown 1985). In this

situation, all items are arranged towards the periphery of the circular projection. An example of this form of arrangement would be of events that are isolated by being representatives of a class but that are not more or less of any type of evaluation.

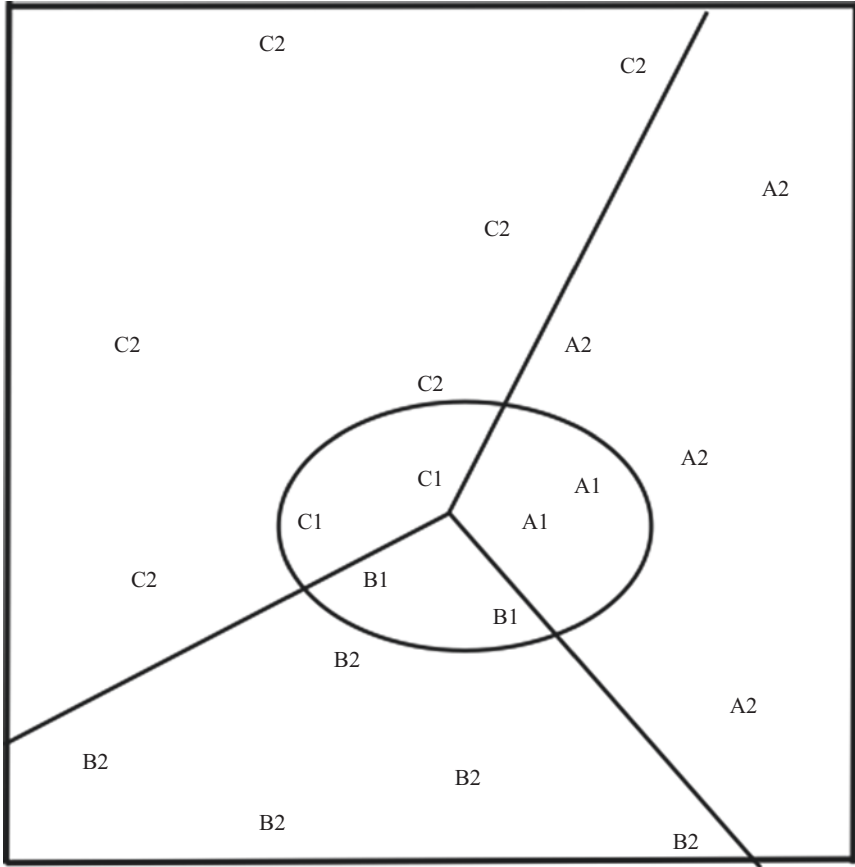
So far, I have considered the structure of facets that have a relatively independent effect upon the content domain they are classifying. Sometimes however, single facets are found to co-exist and modify each other in reference to a specific domain. In these situations, there are facet structures that are composed of a plurality of facets.

## Two facet structures

### Radex

A common example of two facets forming a combined role is when a modular facet is found to co-exist with a second facet playing an angular/polar role. In this situation, a person makes a concurrent evaluation, or possesses an understanding of a situation that is typified by the combined and simultaneous effects of multiple facets in a coalesced role. An example of such a situation would be when an event is understood in terms of its extent (such as importance or centrality) along with differentiations of the same content into relatively discrete and different regions (for instance different species of animals). In this situation, the second facet modifies the former, and vice-versa. The structure formed by the combination of these two facet roles is called a radex (Lingoes 1973). In this amalgamation, events are both conceived as being simultaneously more general or particular when understood by the content of the first facet (a modular role) and to also be understood as being of qualitatively distinctive types of events (polar role). An example of this arrangement of facets is provided in the mapping sentence for animals given earlier in this chapter. This dual facet structure can be seen in the combination of animal species (modular role facet) with personal importance (polar role facet). Here an animal may be, for example, a dog that is of little personal importance.

As well as two facets combining to play a joint role in reference to a content area, it is possible for a greater number of facets to join together (Fig. 3.8).



**Fig. 3.8** Facet role: Polar + Modular

Figure 3.6 Polar + Modular Facet Roles

### Three Facet Structures

#### Cylindrex

I have already described the radex, which is formed by the combination of a non-ordered facet with an ordered facet. In this facet combination the non-ordered structure of a polar facet combines with the wedge-like



arrangement of elements from a modular facet (an example of a cylindrex is present in Fig. 5.7). The result is that centrally located events are more generally related to the research domain. A common structure present in facet theory analyses is that of the cylindrex. The cylindrex structure occurs when a third facet is present with the two facets of the radex. When I say a third facet is present, I mean that a third form of understanding (in the form of a third facet) concurrently structures respondents' evaluations. This third facet plays an axial role, orthogonally associated to the radex structure and causes evaluations to be differentially allocated to parallel regions in geometric space. The structure formed by the facet combination is three-dimensional and results in a stacked series of radex structures each of which exist at each level of the axial facet. The arrangement may be visually depicted as a tube with a top, bottom, and a number of slices parallel to the top and bottom slices: The cylindrex appears as several radexes stacked upon each other. In the animal mapping sentence example, the radex formed by species and importance facets would combine with the size facet, which would form the height of a cylinder with a radex present as several slices through this structure.

### Conex and Cubex

Other structures of three facets in combination also occur such as that of the *conex* and the *cubex*. The conex structure is similar to the cylindrex but narrows towards one of its ends: The radex that compose the tip of the axial dimension of the cylindrex are more centrally focused than the radex that composes the base of the conex (Levy and Guttman 1989). A cubex is another three-dimensional facet structure that is this time formed by the combination of three simply ordered facets resulting in a cube-like structure. In the above sections, I have provided, in a terse fashion, some of the basic structures that are regularly found to organise human behaviours and experiences.<sup>10</sup> In the following section, I will review, in a similarly epigrammatic manner, the ways in which data that arises from, and is analysed in, facet theory driven research.

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<sup>10</sup> A more thorough account of the structure and nature of facets are provided by Jennifer Brown (1985) to whom the interested reader is directed.

## Analysing Facet Theory Research

In this final section of this chapter, I consider some of the ways in which the data that is produced through traditional quantitative facet theory research is analysed. In a later chapter, I consider analysing information from Qualitative facet theory studies.

Quantitative research designer using a traditional facet theory approach yields complex data sets and demands intricate forms of analyses. Multidimensional scaling (Kruskal and Wish 1978) is used to produce the geometric arrangements of conceptual space that I have been referring to in the preceding paragraphs of this chapter (for example, the cylinder, radex, simplex, etc.). Details of the statistical procedures that analyse such quantitative data and produce these geometric print-outs are beyond the remit of a book that presents the philosophical evolution and application of facet theory. Readers who are interested in the statistics behind quantitative facet theory are guided to Borg et al.'s (2013) excellent introductory expose on multidimensional scaling (MDS).

However, it is important to briefly note that quantitative facet theory analyses constitute a series of multidimensional scaling techniques, namely, Smallestspace Analysis (SSA); Multidimensional Scalogram Analysis (MSA); and Partial Order Scalogram Analysis with Base Co-ordinates (POSAC). Each of these procedures has its own computer programmes and is found in the HUDAP (Hebrew University Data Analysis Package) suite. The three programmes, and the type of analysis that it performs, has been developed out of a desire by facet theory researchers to economically represent the wealth and richness of the numerical data that they have collected in their research. As a consequence, the analyses procedures were developed as nonmetric statistics to numerically represent qualitative data, '... without losing the qualitative features of the data'. (Gratch 1973, p. 38).

As well as using the HUDAP suite of programmes some researchers have employed procedures written in R or have employed other more widely available statistical programmes. For example, some scholars compute correlations and scale the coefficients using confirmatory multidimensional scaling using a widely available MDS statistic and there is

some debate as to whether a non-metric or a parametric MDS procedures should be used. Similarly, some have noted the age of the SSA algorithms, that they may not converge to a local minimum and that the SSA programme does not use an up to date methodology (Borg 2020). It is worthy of note that with small data sets bootstrapping procedures have been used with around one thousand random permutations of the data.

## Smallestspace Analysis

Smallestspace analysis has been the most commonly employed form of facet analysis and these analyses are what produce the facet roles of which I have spoken. Smallestspace analysis is often used as a way of analysing and exploring data sets to map content areas. Karni and Levin (1972) described smallestspace analysis as a procedure that employs nonmetric intercorrelation matrices to analyse proximity relations. In this form of analysis “variables are represented as points in Euclidean space so that the rank order of the interpoint distances corresponds to the rank order of the intercorrelations.” (p. 341). The output of smallestspace analysis a series a plots of the research variables and the closer the variables are to other variables the more positively correlated they are. Variables are characterised by one element from each facet and partitioning lines are drawn to capture variables with similar elements for the facets. Being able to successfully partition variables by facet elements supports the veracity of the facets in structuring responses and the shape of the partitioning reflects the psychological processes employed by respondents.

As I previously noted (Hackett 2014), assurance in the psychological inferences arising from specific arrangements of facets is produced in smallestspace analysis through regional partitioning of items to allow boundaries of facet elements to be established. Confidence in the validity of a facet grows when structural consistency is repeatedly demonstrated in different pieces of research: Semantic similarity between variables in smallestspace analysis is calculated from the strength of association between variables and shown graphically in two-dimensional printouts. Example of a resulting smallestspace analysis plots are given in Figs. 3.3,

3.4, 3.5, and 3.6. Two other facet analysis approaches analyse data arising from the same research instruments to uncover different information.

## Multidimensional Scalogram Analysis

Multidimensional scalogram analysis is an analysis technique that has been productively used to provide understand of individuals in terms of their profile of responses rather than responses to individual questions. In multidimensional scalogram analysis, the data is recoded to be dichotomous (in terms of presence or absence of the variable's quality) and a series of data profiles for individual respondents are in this way created: The creation of profiles allowing the comparison of respondents. The multidimensional scalogram analysis procedure examines the relationship between respondents simultaneously across the variables in their profiles. The output of multidimensional scalogram analysis is a two-dimensional geometric plot that reflects the similarity of individual respondents the power of the similarities between individuals across their profiles such that dichotomous profiles are printed as points with similar profiles appearing closer in the plot (Canter 1985; Guttman and Greenbaum 1998). Plots are divided into areas where these areas in the plots identify respondents who are similar in terms of a variable (Borg and Shye 1995; Wilson and Mackenzie 2000).

Multidimensional scalogram analysis also yields an individual item plot for each variable in the profile which allows comparison of plots in relation to characteristics of respondents (Porter and Alison 2006). For example, an item plot may divide respondents in terms of a specified dichotomous variable, with the two groups of individuals so formed located in different regions of the plot. The plots may then be overlapped to allow a determination of the way in which each of the variables contributed to the overall arrangement and areas identified in the main plot (Trojan and Gabrielle Salfati 2010).

## Partial Order Scalogram Analysis

The final facet analysis approach is Partial Order Scalogram Analysis, which allows the profiles of respondent to be compared and analysed (see chapters in Canter 1985 for details of these POSAC as well as the MSA approaches and for POSAC see: Levy 1998; Levy and Guttman 1985; Shye 1985; Shye and Amar 1985; Wiley and Levi 1999). Partial order scalogram analysis with base co-ordinates is also a nonmetric statistical method that is similar to multidimensional analysis in that it analyses variable profile scores of individual respondents and produces a series of two-dimensional geometric plots. Partial order scalogram analysis graphically locates profiles so that each profile is located close to other profiles with similar scores on each of the profile variables. Sabbagh et al. (2003) stated that partial order scalogram analysis has abilities that other statistical analyses techniques do not have. As with multidimensional scaling techniques, in general, it reveals the underlying structural qualities present in a complex data matrix and does this spatially by geometrical representing this in a Euclidean space of the lowest meaningful number of dimensions. However, unlike most forms of multidimensional scaling and factor analysis it attempts to discover differences between individual respondents.

Partial order scalogram analysis attempts to reveal differences between respondents that may be lost if averages or other statistics are calculated. For example, if four questions can be answered yes or no, where yes = 2 and no = 1, and one group of respondents replied with a profile of 2,2,1,1 and a second group with a profile of 1,1,2,2 whilst a third group responded 1,2,2,1 and a fourth 2,1,1,2. The average score for each group is the same (1.5). However, the psychological content is totally different for each group. POSAC analyses these profiles in terms of the quantitative differences (summed scores for all items) and qualitative differences (the scores for the individual questions). Using Hasse diagrams, partial order scalogram analysis with base co-ordinates plots items in two-dimensional space where the position of items is determined by both qualitative and quantitative characteristics of the responses and shows subgroups that have distinctive responses styles. It should however be noted that it has

been suggested that using an unfolding procedure instead of POSAC may be more appropriate (Borg 2020).

Having briefly presented SSA, MSA, and POSAC, I will now finish my consideration of statistical analyses, as it is not my purpose in this book to provide details of quantitative analysis procedures but to concentrate upon qualitative and philosophical aspects of the facet theory approach.

## Conclusions

Sociologist C. Wright-Mills (2000) spoke of the ‘sociological imagination’ and stated the necessity for a sociologist to have a way of looking at the world that enabled an appreciation of the social forces acting around individuals living amongst and within social institutions and social systems. Dimen-Schein (1977) invoked the ‘anthropological imagination’ or a desire to build knowledge and understanding about our own and other cultures, as being requisite in all anthropological endeavours. The *facet theoretical imagination* is, I propose, a distinctive understanding of the nature of existence, which embodies a particular way of conceiving the study of human-animal and non-human-animal behaviour. This imagination encompasses ideas of structuring behaviour and experience as identifiable facets of an area of interest and then combining these in holistic narratives, which involves conceptions of individual facets and their elements and the combination of facets within mapping sentences. The *facet theoretical imagination* impels whoever possesses such an outlook to think of pertinent aspects of individual or social life that is being modelled in terms of each aspect performing as one of the single facet roles: for example modular, planar. This *imagination* also implicates the holder to envisage behaviour and experience as being complex events and to develop more multifarious awareness through the imagining the complexity of facets being combined in a mapping sentence. Thoughts regarding the confidence in the statistical pertinence of our claims and notions are rejected, as are ideas of linear ‘ladder like’ dimensions with evenly spaced steps that we all ascend and descend in a common manner and which form our thoughts and feelings.

Facet theory has existed for approximately three-quarters of a century and as we have seen, during this time many areas of human endeavour have been subjected to its survey. The Facet Theory Association regularly produces a bibliography that lists facet theory publications and a cursory review of the academic journals in which these publications have appeared provides an idea of the typical content of this research with the most frequent subjects areas being: social indicators; psychology (applied, social, environmental, legal, criminological, cognitive, political) personality and individual differences, assessment and measurement; education (religious, assessment and measurement); behavioural genetics; complementary medical; business management; organisational behaviour. Facet research in these and many other areas has produced insightful results, which has yielded regularities in some of the geometric structures found in facet analysis. This has led to the establishment of predictable roles being played by facets in these situations. Common structures include those previously noted: simplex (Guttman and Guttman 1965), circumplex (Martinez-Arias et al. 1999), radex (Guttman 1954; Shye 2009), axial facets (Hackett 1995), modular facets (Meyer Schweizer 1993), and polar facets (Levy 1981). Facet research has explored and developed theories about many areas of human behaviour and the scope of coverage is indicated in the publication areas listed above. As well as focusing upon many distinct research areas, facet research has often addressed a single research area and this interest has been divided into sub-regions. For example, in education aspects have been considered including: students' course evaluations (Cohen 2000, 2005), ethnic identity within educational contexts (Cohen 2004), university students' quality of life and experiences (Cohen et al. 2001; Hackett 2014), the role and membership of parent teacher associations (Fisher 2018), students engagement (Assor et al. 2002), student acculturation (Treister 2005), college student's feelings of academic challenge, St Clair and Hackett (2012a, 2012b), understanding ethnic discrimination (Kanavou 2003), self-efficacy and other psychological features of high-school principals (Fisher 2011, 2014), students' perceptions of the learning environment and justice experiences (Alt 2014), professional ethics (Fisher 2013) and school management (Fisher and Friedman 2008).

The interested reader is guided to the many facet research studies listed in the bibliography.

Throughout this chapter, I presented an account of facet theory and mapping sentences. I have attempted to offer the reader with an understanding of both traditional quantitative facet theory with its traditional mapping sentence along with qualitative facet theory using the declarative mapping sentence. I have however concentrated on the traditional quantitative approaches. In Chap. 4 of this book, I will concentrate on qualitative facet theory and the declarative mapping sentence.

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# 4

## The Declarative Mapping Sentence and Qualitative Facet Theory Research

**Abstract** In the earlier chapters of this book, I have presented facet theory and mapping sentences in both their quantitative and qualitative formats. However, I have emphasised the traditional mapping sentence and quantitative facet theory research. In this chapter, I concentrate on more recent forms of mapping sentences and facet theory and provide a review and examples of qualitative facet theory and the declarative mapping sentence. To achieve this, I will consider the declarative mapping sentence in greater detail and then consider its application in a study into fine art that takes into account perceptual neuroscience and visual impairment. The study employs the declarative mapping sentence to allow the investigation of the modern art trope of the grid image through theoretically reviewing extant grid images. Uniquely, the mapping sentence then provides a guide for painting a body of work, which constitutes both the investigation and validation of the mapping sentence. Other qualitative uses of the approaches are also presented. The chapter ends with suggestions for future research.

**Keywords** Facet theory • Declarative mapping sentence • Mapping sentence • Fine art • Visual impairment • Qualitative research • Philosophical enquiry

## The Evolution of Facet Theory

Theories are explanations of events and phenomena in our world and as the world around us changes so must our theories. Facet theory is no different to any other theory and we must resist the urge to necessarily preserve it in some unchanged state and to keep on asking similar questions to those we have asked before and to discover similar answers. It is perhaps a strength that a theory possesses if the theory can adapt whilst remaining coherent in its underlying theoretical principles. Facet theory has changed and developed over the years and most recently, it has moved from being a solely quantitative approach to addressing qualitative information. This transformation has not been accepted by all scholars and I have recently been told that the facet approach is a statistically based approach to the hypothetical-deductive method. This statement is indeed true. However, facet theory is so much more than just this. It is my opinion that the most important aspect of facet theory is the mapping sentence and what I have already described as the facet theory imagination. Moreover, both of these parts of facet theory are eminently appropriate for use when approaching qualitative and more philosophical forms of scholarly activity. Conceived in this manner, the approach is exceedingly flexible, which I will demonstrate later in this chapter through reporting upon how I have used a declarative mapping sentence to both understand art and to create artworks.<sup>1</sup>

It should however be understood that my conception of facet theory incorporates a sensitivity towards the research experience. Paul Capobianco (2019) emphasises this point when he states that in my writing (e.g., Hackett 2014a) “The mapping sentence is presented as an extension of this imagination: the embodiment of a stance that structures behavior and experience in terms of discrete categories or facets within

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<sup>1</sup> An earlier version of this chapter was published in Hackett (2020b).

which are sub-units or elements meant to exhaustively account for each facet's variations." (Capobianco 2019, p. 12).

Following on from my own proposition of a qualitative facet theory (Hackett 2014a), David Canter has recently proffered 'qualitative structural theory' (Canter 2019), which is a half-way-house between a thoroughly qualitative appreciation of facet theory and the traditional quantitative rendition of the theory.

David Canter has been to the fore in advocating the need for a theoretically rigorous approach to facet theory research, rigor combined with his own open-minded and flexible usage of the approach. Canter's view is most clearly evident in the vast literature he has authored, co-authored, and the research literature that has emerged from researchers associated with him, in the area of what he calls *investigative psychology* (for an overview see, Youngs 2013). Investigative psychology is the study of both offenders and the ways of apprehending them and involves using psychological understanding at all points of the crime investigation process. It is concerned with criminals, prosecutors, law enforcement agencies and other related parties (Canter and Youngs 2009). Young has claimed that Canter's broad based 'facet approach' both in the field of applied criminology and within a more general academic context represents '... an approach to psychological research, through the development of this (investigative psychology) discipline, which has relevance far beyond the criminal context.' (Youngs 2013, p. 3). Canter's work has greatly extended the ways in which facet theory has been conceptualised and applied to investigate human behaviour.

Other researchers such as Proudfoot et al. (2011) have used facet theory in an extremely abbreviated, almost schematic form. They cited Guttman and Greenbaum (1998) as their source for using facet theory and the mapping sentence as a hypothesis generator that did not seek recourse to empirical data gathering. In their research, formal hypothesis testing was via expert opinion about their twelve-facet structure for understanding internet intervention research.

As can be seen, there has been an extension of facet theory beyond its traditional realms and in the following sections I briefly report upon some of my own, more novel, uses of the facet approach.



## Mapping a Domain: The Mapping Sentence as a Stand-Alone Approach and Integrative Tool

The mapping sentence is at the heart of the facet approach to exploratory and confirmatory research. In this section, I offer support for the mapping sentence as a tool to integrate research that does not use facet theory in its execution. In such a situation, the mapping sentence allows formal and exacting consideration of the variables that comprise a research domain. I also present the mapping sentence as a stand-alone tool for conceptualising a complex understanding and investigation of human behaviour and experience. I advocate the use of the mapping sentence in a non-orthodox manner and in a way that requires the collection of qualitative data rather than the usual numerical information. Canter, in his investigative psychology, has evaluated qualitative materials such as personal narratives from criminals. Indeed, Canter stresses the importance of using ‘... careful description and categorisation’ as the basis for theory development (Youngs 2013, p. 14). I have used the mapping sentences as a stand-alone technique in several applied research areas in which I did not employ traditional facet analysis (smallestspace analysis, etc.). For example, I have utilised the mapping sentence as a definitional tool within visual research, classifying fine art images and then as a guide for painting fine art works that explore the content domain specified in the mapping sentence. Through my research, I have developed a specific form of the mapping sentence for use with non-numerical information and which typically does not possess a range facet, which I have called the *declarative mapping sentence* (Hackett 2020b).

### The Need for and Use of the Declarative Mapping Sentence

So far in this book, whilst I have considered both the declarative and traditional forms of mapping sentences I have concentrated mainly upon presenting the traditional form of mapping sentence. In this chapter, I

provide further details about the declarative mapping sentence which I use to support my assertions that it is both appropriate and profitable to use this form of mapping sentence within qualitative research and philosophical scholarship. I also provide examples of the use of the declarative mapping sentence in order to provide further information about the approach and its philosophical and linguistic antecedents. Hereunder I provide several examples from both my own research (including studies I have undertaken in the areas of philosophy and fine art) and examples that derive from the scholarship of others. The examples I present include studies concerned with religious behaviour, the evaluation of IT systems, clinical reasoning and other diverse illustrations. Moreover, I argue that it is a necessity to provide transparent definitions, in the form of well-structured mereologies, which offer boundaries to a research domain and suggest the structural qualities of the concepts contained within the specified domain. I propose that the declarative mapping sentence is an extremely useful instrument for designing, carrying-out, and analysing research that is both non-numerical and complex.

Qualitative research is often seen to have weaknesses when compared to quantitative forms of enquiry, such that it is imprecise and may not be generalized outside of the sample used in the research. However, quantitative research also has its weaknesses, for example, the abstract nature of its studies and its reductionist tendencies. Indeed these and other weaknesses of quantitative research have contributed to my motivation for developing the declarative mapping sentence for use in qualitative research. Qualitative approaches provide rich data and insight and offer peerless levels of understanding of the lived experience of a phenomenon. I developed the declarative mapping sentence as a flexible template for qualitative research with the additional aim of using this as a framework to facilitate greater levels of comparability between findings from different qualitative studies. The declarative mapping sentence also provides the researcher with increased levels of confidence in their findings.<sup>2</sup> The

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<sup>2</sup> It is important to state at this point that not all researchers would agree that as lack of comparability between research studies is a problem. Indeed some would claim this as a virtue. I am drawn to this argument as I see great merit in the one-off, individualistic study. However, I also feel numerous instances exist in which the ability to directly compare different qualitative research studies would be both interesting and productive in terms of knowledge generation (Hackett 2020b).

fundamental utility of the mapping sentence is demonstrated in Paul Capobianco's description of the process of using a mapping sentence to guide research:

the reflexivity of a mapping sentence built into the systematic methodology prescribed by facet theory compels the researcher to ask in what ways the collected data gels or does not gel with the mapping sentence's facets; that is, to what extent the hypothesis about the categorial breakdown of the domain in the mapping sentence is respondent-appropriate and relevant to how an individual actually "understands" their experience within the domain's complex context. Capobianco 2019, p. 13

Both forms of mapping sentences (traditional and declarative) act in the role suggested by Capobianco as they are very similar as they are both explicit statements of a research domain which is achieved by exhaustively identifying the important aspects or variables (facets) and their components (elements). Respondents are also specified for a specific study. All mapping sentences are formal propositions in regard to the content they are specifying. Research that utilises a mapping sentence does not use the mapping sentence as an unsupported statement. Mapping sentences may take this somewhat remote and abstract form at their conception but they must then progress to include information that is gathered from participants in the research, the literature, scholarship, and so on. Through this process, mapping sentences progress beyond being simply speculative.

Mapping sentences in all their uses offer propositional statements of an area of interest that is subject to investigation in order to test the veracity of the mapping sentences structure.<sup>3</sup> Qualitative research explores and produces rich insight by revealing the feelings and thoughts of individuals towards a state of affairs, object, event, and so on. Geertz (1973) noted that 'thick descriptions' were at the heart of qualitative research, description that went beyond a terse statement in regard to a phenomenon and several authors (e.g., Gorli et al. (2012), in the context of multi-method research) have noted how qualitative research can offer meaningful

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<sup>3</sup>In Hackett (2020b) I present an example of how the use of both traditional and declarative mapping sentences to view and explore a single content area, which in this example is bird behaviour.

insight. Thick descriptions are developed by a researcher as rigorous accounts of human activities that incorporate contextual information and which include comments, explanations, and observations from research participants. Such descriptions provide documentation of the whole of an experience including expressions of what the event means to a person or persons and which allows for a deeper level understanding to be communicated to readers of such narratives. Gorli et al. (2012) commented upon how qualitative research worked with thick data in order to produce descriptive information and knowledge, which was idiosyncratic but deeply and personally meaningful.

However, Hackett (2020b) wrote that the deeply personal and rich nature of qualitative research is not only a strength but that this may lead to the findings that arise from qualitative research being fragmented and disconnected from existing research that was concerned with the content domain. The outcome of such fragmentation may be the retardation in theory development about the phenomenon of interest.<sup>4</sup>

A consequence of the difficulties associated with directly comparing the results from different qualitative research studies may have led to some social and psychological researchers turning to quantitative approaches in their studies. In quantitative research, stringent sampling methods are clearly defined and explicitly stated research variables enable quantitative research approaches to produce results from which researchers may generalize to a broader population from their specific project's findings (Lincoln and Guba 1985).

The criticism that qualitative research is only able to be directly informative and speak with authority only about the sample of respondents used in the specific study may appear damning and may incline towards a quantitative approach. However, numerical research too has its critics. For example, the conversion of human behaviour and experience to a numerical measure means the study and its results become distant from the real, actual experiences of those living within the context of the event that is under investigation. Numerically based research also analyses data using statistical methods which are seen by many to lessen or even negate the rich and personal qualities of the understanding that is developed in

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<sup>4</sup> See, Polit and Beck (2010) for a discussion on generalizing from qualitative and quantitative data.

qualitative research (Townsend et al. 2010). Moreover, numbers have the proclivity of suggesting a spurious notion of precision and due to the universality of numerical systems a sense that results analysed numerically are themselves universally applicable.

Hackett (2020b) offered examples of familiar situations in which numerical rating scales may be used in familiar situations and how this may be problematic and provided the example of a doctor asking a patient about their experiences of pain. It is quite likely that we have been in the situation of a doctor asking us to rate how severe a pain is on a scale of 1 to 10 (very little pain to excruciating pain). Asking this question provides the doctor with very useful clinical information and insight. However, a response to a question like this would be unlikely to produce a response that is comparable between individuals. This is common sense as one person may have given birth or have been involved in a major accident in which they were severely injured. Such an individual may rate the pain their current pain experience from a tooth ache as “4”. However, an individual who has not previously experienced a severe form of pain may rate the current pain as being “8 or 9”. Moreover, people are individuals, both physiologically and psychologically, and regardless of previous experience, people differ in terms of both how they experience the world and the language the use to communicate such experiences. The problem therefore in using such a rating is using it under the assumption that it is either comparable with ratings from other people or assuming that any form of parametric statistical analyses of this data would yield valid results. I would suggest that it is here of more value and interest to gather personal histories and the stories and personal experiences along with a description of their present pain experience.

Hackett (2020b) also made reference to the example from the research of Edwards et al. (2004). These researchers were concerned with physiotherapy techniques and noted that people were often asked to rate their experiences on a 0 to 10 scale (that was similar to the above noted procedure). They claimed how patients’ experiences were made abstract through the use of a numerical scale and that this form of data did not adequately reflect or portray the sophistications of the therapeutic procedure. They too believed that experiential narratives would better capture and convey patient experience and that numerical assessments in this

situation constituted a metaphorical manipulation of the experience of pain.

The traditional mapping sentence was developed in order that quantitative data may be gathered that reflected the combined interactions and effects of multiple variables (facets) in structuring experience within a specified content domain. The strengths of a quantitative approach is in its ability to produce data in which confidence may be held and which the researcher may generalize outside of the context of the study within which it arose. However, I have noted the weaknesses of the quantitative approach and the problems of numerical reductionism. With the problems of quantitative research in mind I have developed a qualitative facet theory (see e.g., Hackett 2014a, 2016b, 2020). The first and most important change that I made in my qualitative conceptualisation of facet theory was the removal of the range facet from the mapping sentence. This important alteration was made as it is the range facet that specifies the responses that will be gathered in a piece of facet theory designed research, and traditionally it specifies these as being numerical. In the next section of my writing I will discuss the range facet and below (in Fig. 4.1) I provide an example declarative mapping sentence that attempts to encapsulates the influences upon a person that may affect their experience of reading a book. I include this declarative mapping sentence to aid this discussion.

## The Presence or Absence of the Range Facet

The example of a declarative mapping sentence given in Fig. 4.1 lacks a range face. The range facet is absolutely essential within the traditional mapping sentence as it provides the coherence to responses to the content of the mapping sentence, orients the respondent to the content domain that is being investigated and assures consistency in the responses and in how they are analysed.

The absence of a range facet is an extremely important aspect of the declarative mapping sentence and is a consequence of the open-ended forms of data gathering that is undertaken in qualitative research. The reason for the removal of the range facet in the declarative mapping

**medium**

Person (x) experiences reading the book in terms of it being read: as a book

on a reader

on a computer/tablet

on their phone

**reason**

where their aim is to read the book for: pleasure reasons, and where this is

education

work

**location**

**social**

read: at home and whilst they are: alone

whilst traveling with friends

at work with family

at college with colleagues

**Fig. 4.1** Example of a declarative mapping sentence for the experience of reading

sentence and the reason that this is a strength is because its removal allows different types of observations and other forms of information to be gathered and understood within the framework of the declarative mapping sentence's definition of the content domain of interest. On this understanding of a mapping sentence, it is a template which structures a domain and allows direct comparisons to be made between studies and for knowledge to be developed through such comparison. If a researcher decides to include range facet in a declarative mapping sentence it is included in a form that does not specify specific measurements of outcomes, it never specifies numerical or quantitative outcomes, and it will tend to be stated in broad terms.

An example of a declarative mapping sentence with a range facet is that used by Wihlborg et al. (2019). The range in their declarative mapping sentence is not a true response range and numerical responses were not gathered from respondents across such a range. Instead, the researchers used their declarative mapping sentence to develop a qualitative research study and following the completion of the research they performed a secondary-analysis of the qualitative information that they had gathered during a group discussions. The authors then allotted the discussion to one of two dichotomous options on what they called an 'organisation range'. In doing this, they organised the qualitative information they had gathered using their mapping sentence. By using the declarative mapping sentence in this way, they employed the ontological and mereological characteristics of the mapping sentence's facet, elements, and connective phraseology to organise their data and the organisational range was used to designate the epistemological features of their observations. Here, the organisational range was a component of the mapping sentence's logic instead of being a delimiter placed upon what constituted a valid response from a subject.

When used within qualitative research a mapping sentence acts as a template for designing, gathering and analysing the information that is provided by participants. The trustworthiness of a declarative mapping sentence is assured through the stating of facets, elements, and connective phrases, the repeated use of the declarative mapping sentence and its ability to promote consistent and comparable understanding of the phenomena being investigated. Furthermore, in both traditional and



declarative mapping sentences the legitimacy of a sentences' stated facet structure is established through the instituting of a rational and convincing relationships between the specified facet structure and the real-world phenomena to which the mapping sentence applies. Without the range facet being present, a declarative mapping sentence may expedite the development of knowledge in relationship to broader conceptual domain more responsively than when a traditional mapping sentence is used. An illustration of this breadth is demonstrated if a declarative mapping sentence was used in the investigation of dental treatment. In this situation, participants could be requested to critically engage with the experiences they have had of dental treatment and a declarative mapping sentence would provide a framework for the interpretation of the data that arises from interviews, observations, sort procedures, and so on. Such a mapping sentence would also allow a flexible though comparable analysis of the different forms of data gathering. A traditional mapping sentence when used to assess dental treatment, on the other hand, must specify a range of acceptable output from the research instruments used this phenomenon. For instance, the range could be stated as the level of satisfaction they experience, the frequency of their visits, their willingness to pay for the treatment, or a host of other outcomes. However, respondents could not explicitly combine response ranges when they offer an answer although they may in fact be doing so implicitly, nor can they proffer an expression of regarding what they think or feel about the specified range provided except by responding within this range.

In order to more fully understand the way in which a declarative mapping sentence functions and how it may establish itself as a trustworthy research instrument for the domain to which it is applied, it is useful to consider the sentences generic composition in greater detail. A declarative mapping sentence always includes the person or persons who are its subjects or participants or indeed the person who is reading, understanding, and/or in some way responding to, the declarative mapping sentence.<sup>5</sup> Background facets may also be present in a declarative mapping

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<sup>5</sup> It is also possible to have non-human animals as the subject of a mapping sentence (see, Hackett 2020b) or indeed inanimate objects or concepts as the subject of a mapping sentence who applied the mapping sentence to objects of fine art (see, Hackett 2013, 2016a, 2017c).

sentence in which they specify the characteristics that are considered to be aspects of the research domain or situation that are important to include in research in order to understand the research domain or are influential in the instantiation of the mapping sentence ontology. A mapping sentence ontology is also specified in a declarative mapping sentence in terms of both a content ontology (sub-components of the ontology in the form of facets and facet elements) as well as a connective ontology (the words and phrases that are used to connect the facets and facet elements). A declarative mapping sentence is also overt and explicit as it clearly defines the relationships present within the mapping sentence's ontology in terms of both part-to-part (facet/facet element-to-facet/facet element) and in terms of parts-to-whole (facet/facet element-to-mapping sentence).

Above, I have been describing the declarative mapping sentence and its characteristics and I now consider the practical questions of when and where it is appropriate to use a declarative mapping sentence in a research project.

## **When and Why to Use a Declarative Mapping Sentences**

I have developed the declarative mapping sentence through research and scholarship in which facet theory has been as a philosophical orientation in which the world is conceived such that life is conceived as complex and full of phenomena and events that are intertwining (Hackett 2013, 2014a, 2016b). Consequently, over recent years I have modified the traditional mapping sentence and quantitative facet theory to be used with in non-numerical research. When examinations of research information that has been gathered at different times and in varied locations is examined by qualitative researchers and their interpretations are consistent, then the information has been interpreted in a reliable manner and hermeneutic consistency is present. My aim in extending the mapping sentence's usage into qualitative enquiry was in order to facilitate hermeneutic consistency through its employment. Initially I did not rename the traditional

mapping sentence in order to identify my distinctive form of this tool. However, this led to some people misunderstanding my adaptation of the mapping sentence. I therefore renamed the traditional mapping the declarative mapping sentence to distinguish this instrument when used with non-numerical data. The new name also emphasises the point that a range facet is likely not included in the declarative mapping sentence and that this is intentional and not a mistake. I have used the declarative mapping sentence in a variety of situations as demonstrated in the following publications: (Greggor and Hackett 2018; Hackett 1983, 2013, 2014a, b, 2015, 2016a, b, 2017a, b, c, 2018a, b, c, 2019a, b; Hackett et al. 2011, 2016, 2018; Koval et al. 2016; Lou and Hackett 2018; Schwarzenbach and Hackett 2015; Shkoler et al. 2020).

The declarative mapping sentence offers an empirically and theoretically valid framework (a generic although adaptable structural ontology) within which to design and interpret qualitative research. The findings are potentially hermeneutically consistent because the structure of the ontological components in the declarative mapping sentence remains constant whilst its contents emerge from the specific information gathered. This allows the mereological relationships between various aspects of the research to be initially hypothesised whilst permitting the substance and combinatorial meaning of the elements present in an enquiry to be idiosyncratic to a participants' and to be determined by them. In this chapter, I expand upon and attempt to support these claims through considering the metaphysical and linguistic sources of the declarative mapping sentence and review how both others and I have employed the framework within research in the social sciences and humanities. My argument for the trustworthiness and utility of the declarative mapping sentence rests upon the overall structure of a sentence being an appropriate instrument into which may be incorporated the meaning of complex research domains and then used to design further enquiries (Hackett 2020b). In the following sections, I provide some illustrative examples of how I, and others, have used the declarative mapping sentence in selected research studies.

## Mapping Sentences and Abstract Fine Art

Each of us perceives and understands art in a highly idiosyncratic manner. This is never truer in the context of various types of abstract fine art. In this situation, one person may perceive a master piece whilst another person may say that their ten-year-old daughter could have done a better job! There is therefore a problem in defining what art is and as a consequence of this, several different bases for such definitions have been proposed. Any definition of art must comprise the conditions that are needed to delineate what art is and for a definition to endure it cannot be refuted even by a single example that falls outside its definitional properties. There are several orientations that can be taken towards attempting to understand fine art. For example, many scholars (Dickie 1974, 2000; Bachrach 1977; Fokt 2013; Oppy 1991; Stecker 1986; Wollheim 1987) have upheld an institutional theory or definition of art: “institutions such as museums and galleries, and specific agents working within them, have the power to dictate what is art and what is not.” (Oxford Reference 2020). Another perspective is the one assumed by philosopher Paul Crowther (2007) in his consideration of an aesthetic orientation towards art and the functions that art performs. However, in my research, it was not my aim to answer grandiose questions in regard to what constitutes art. Instead, I conducted research and extended the use of a mapping sentence into this highly subjective and qualitative area of human experience with the aim of using the mapping sentence as a framework for descriptive discussion about art (Hackett 2013, 2016a, 2017c).

Crowther (2007) attempts to answer questions such as: what constitutes art, what accords value to an artwork and what are the criteria for establishing the merits of a work of art. He adopted and extended a phenomenological perspective in which he emphasised rudimentary features of human perception and related these to both contemporary as well as abstract visual fine art. Additionally he questioned whether what we may think of as the value of a piece of art is rooted in aesthetics and suggested a model to assist in understanding the value of a piece of art that incorporates such perceptual features as imitation and representation. Other somewhat intangible aspects of an art work were also

included, such as, knowledge, the understanding a viewer brings to the situation of the historical links that may be incorporated and even hidden in an art work and the piece's associations with the art canon. His model comprised features of an art work including; image; temporality; meta-physical depth; notions of the art canon; context; cognitive structure, and he emphasised the importance of the style of a piece, where original style may be linked to artistic merit (Hackett 2020b). Crowther concluded that in the post-modern, consumer age of the last twentieth century artistic value has been degraded to a point where fashion and trends in society and the economy determine both the significance and value of a work of art (Crowther 2007).

In my research and writing about abstract fine art, I was initially interested in abstract two-dimensional fine art (Hackett 2016b) and subsequently in three-dimensional forms of abstraction (Hackett 2017c)<sup>6</sup>: In both cases, I incorporated Paul Crowther's structural ontology, which he believes provides a theoretical structure for understanding of abstract art. He offers this as an account for the phenomenological experiential components of the complex contextual rooted aspects through which we come to understand our visual art experiences.

Crowther's model possesses eight characteristics which are combined and/or sub-divided, to provide the possibility of comprehensively explaining our experiences of art abstraction. The eight characteristics are as follows: (1) **resemblances** to visual forms through combinations of colours, shapes and textures, as when we see forms in works that are essentially all one colour by, (e.g., Yves Klein); (2) **gestural associations** which are evoked through gestural associations with visual forms, such as our feeling that some shapes or colours are violent or depressing; (3) **revelations of** usually invisible visual features, such as very small surface features, unique perspectives and atmospheric effects; (4) **novel environments** in which events and phenomena exist as a product of usual or novel perceptual environments; (5) **neoteric configurations** that result in the reconfiguration, destruction, remaking of, and so on, of the familiar which

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<sup>6</sup>In this chapter I have chosen to include my research into the experience of three-dimensional abstract fine art (Hackett 2017c). I could have incorporated my work on two-dimensional abstraction but the former has grown out of the latter and I have made reference to the former when this has been appropriate.

result in neoteric visual configurations; (6) **visual suggestions** such as visual traces or suggestions, copies of existing features or counter-factual phenomena; (7) **spatiality/structure** features such as colour, shape, volume, geometry, and so on, that alone or in combination have spatial appearances; (8) **fantasy** imaginary and dream phenomena. (adapted from Hackett (2020b)).

Crowther's model is comprehensive and thorough. In Hackett (2016b) I asked whether his model was able to demonstrate the, "ongoing reciprocal interaction or influence that must exist between different characteristics of such a complex experience as is involved in perceiving, understanding and appreciating, valuing, disliking, etc., of an artwork" (Hackett 2016b, p. 42). I therefore developed a declarative mapping sentence depicting perception of abstract three-dimensional fine art based upon Crowther's understanding whilst addressing what I saw to be the weaknesses of his model (Fig. 4.2). The declarative mapping sentence I offered also took into account the interplay between Crowther's eight characteristics. Furthermore, I proposed that Crowther's features may be better and contextually appreciated within my declarative mapping sentence.

## Making Fine Art

One of the areas in which I have made neoteric use of the mapping sentence includes as a guide for my theory driven research within fine art practice. In the preceding section, I have considered how a declarative mapping sentence was developed to account for a persons' experiences of art works. In the writing that follows, I demonstrate how I have incorporated mapping sentences into the production of the art work itself.

In the context of my art practice, I used a mapping sentence to develop an understanding of modern abstract geometric art and subsequently the mapping sentence acted as a guide for my drawing and painting. The mapping sentence I developed was for the understanding and painting of one specific form of modernist abstract art: the modernist grid in a theoretically motivated rendering of the visual impact of diplopia (I wrote about this extensively in Hackett 2013). The development of this

mapping sentence first entailed the specification of the basic, pertinent ways that I was able to vary in my painted grid images. These were the grid's colour, figure/ground relationship, accuracy of image, orientation, geometry, cell shape, consistency, and background. Having developed this list of the basic facets of the grid that I could manipulate in a grid painting, I then arranged the facets in a manner that logically specified the facet interrelations in the mapping sentence for grid painting (Fig. 4.3).

This mapping sentence allowed me to develop a systematic understanding of how artists had incorporated the constituent parts of grid

	<i>Resemblance</i>		<i>Gestural association</i>		<i>Revealing</i>
	<i>resemble</i>		<i>evoke</i>		<i>reveal</i>
		items –			
		events –			
		states of			
Person (x)	<i>to</i>	affairs –	<i>to</i>		<i>to</i>
viewing an		through the			
abstract three-	<i>not resemble</i>	combination	<i>do not evoke</i>		<i>do not reveal</i>
dimensional		of visual			
artwork,		qualities,			
perceives the		and / or		visual forms,	
optical		through		and / or that:	
characteristics		gestural			
to:		associations,			
		which:			

Fig. 4.2 Declarative mapping sentence for understanding the experience of perceiving abstract art. (Adapted from Hackett 2020b)

	<i>Novel environments</i>		<i>Suggestions</i>		<i>Spatial / Structural</i>	
	<i>use</i>		<i>suggestive</i>		<i>spatial / structural</i>	
items –		items –		of past –		
relations –	<i>to</i>	relations -	<i>to</i>	future –	<i>to</i>	
states of		states of		counter		
affairs - that	<i>do not use</i>	affairs -in	<i>not suggestive</i>	factual	<i>not spatial / structural</i>	
are not		novel		items –		
usually		environments,		states of		
visible, or		and / or by		affairs –		
that:		using visual		and / or by		
		traces that are:		using		
				feature that		
				are:		



characteristics present in a specific abstract three - dimensional artwork.

Fig. 4.2 (continued)



<i>facet</i>	<i>facet name</i>	<i>elements</i>	<i>facet role</i>
A	art medium	a1 painting a2 drawing a3 print a4 other	modular
B	color	b1 colored b2 monochrome b3 grayscale b4 embossed	modular
C	accuracy	c1 precision c2 imprecision	polar
D	geometry	d1 linear d2 curved	axial
E	consistency	e1 consistent e2 inconsistent	polar
F	figure/ground	f1 figure f2 ground f3 changeable	axial

**Fig. 4.3** Facet roles for the mapping sentence for defining grid image variation

G	orientation	g1 perpendicular g2 diagonal	axial
H	cell shape	h1 rectangle h2 square	axial
I	background	i1 literal i2 abstract i3 neutral i4 cartographic	modular

**Fig. 4.3** (continued)

images in their grid painting. I then used this mapping sentence as a guide for the painting of a series of abstract geometric grid artworks that distort the grid within the strictures implied by the mapping sentence whilst preserving a grid's essential 'grid-ness' whilst visually exploring its logical and aesthetic boundaries.

My interest in the modernist and post-modernist grid as an art image comes from the way in which this geometric array uniquely covers all aspect of a two-dimensional visual plane with its more or less precisely prescribed geometry. Throughout the last ten years, I have conducted several research projects and have undertaken various art practices (painting, drawing, print-making, installation) that have investigated the grid. In this work, I concentrated upon the grid as it is typically imagined: two sets of orthogonally intersecting regularly spaced straight lines. This very unelaborated understanding of the grid imposes restrictions upon art practice and the development of understanding about how in their work, other artists had employed and adapted the image of the grid. In addition to representing the visual qualities of the grid image within my painting,

I also used the grid as a tool for depicting the visual impairment of diplopia. The grid was particularly useful in depicting visual impairment as its latticed image totally accounts for a visual plane and distorting the grid likewise presents a holistic account of visual impairment.

Due to the sophistication of my intended visual images and the complex theoretical aspects of normal and impaired vision that underpinned these, I needed a guiding account of the painted grid that would enable me to understanding the ways grid images have been used in modern art. This taxonomical statement needed to be sophisticated enough to incorporate the variations that previous artists had used in their work along with the implications of diplopia upon the perception of the grid, whilst being clear and precise enough to be practically useful in guiding later painting. In the second chapter of this book, I commented at length on how category formation, the allocation of events to categories, and the subsequent arrangement or ordering of categories appear to be fundamental human behaviours. Moreover, categorical ontologies are pervasive forms of how we understand our worlds and they form foundations upon which more elaborate cognitive operations may be built. I have also cited how facet theory's mapping sentence has been used as a template for understanding and conducting explorations into several areas of complex human behaviour. I therefore decided to develop a mapping sentence for the categorical understanding and categorical sequencing for painting of grid-based art images.<sup>7</sup>

Both categorising and sequencing activities are also central to the creation of artworks (figure-ground, figurative-abstraction, foreground-mid distance-far distance). Categorisation and sequencing (or ordering) is present in a manner that is particularly obvious in the images that are based upon the grid image. I closely inspected paintings and drawings of grid images that arose from many artists, schools, and art movements. Influential work viewed included those from The New York School, Bauhaus and artists De Stijl, Piet Mondrian, Tomma Abts, Huszar, Wassily Kandinsky, Sean Scully, Mark Francis, Peter Joseph, and many

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<sup>7</sup>This template in essence formed a mereological account that was needed prior to my painting commenced for me to understand the elements of the grid that I could manipulate and how I could manipulate these whilst still maintaining an image that was unambiguously seen as being 'a grid'.

others. My inspection of these contemporary paintings and drawings revealed that artists had carried and distorted the geometry of the grid from an axiomatic form within a variety of figure/ground contexts. Furthermore, this manipulation had been undertaken in an almost hit and miss random way, and with the exception of artists such as Sol Lewis,<sup>8</sup> these variations of the grid image were largely undocumented. This deficiency in systematic documentation contributed to a paucity of understanding developing about applied and theoretical elements of grid-based art. This lacking was similar to situations where facet theory coordinated research by using a mapping sentence in areas of applied research where previously only atheoretical investigations had been conducted. In these situations, the mapping sentence has enabled the synthesis of the combined effects of multiple influences within the content area of interest. Much of the deficiency in understanding of the grid image was based upon how the parts of the painted grid together formed what is perceived as being 'grid-like'.

I therefore identified the elements of the grid image that had been varied by artists in the works I considered, in terms of physical geometric characteristics of the grid, for instance, its figure—ground relationships. Through this procedure, I refined my definitional framework (mapping sentence) to permit classification of existing grid images. The facets of the mapping sentence were line straightness and density of line; the background to the grid image; and colour elements. Sub-classifications of grid variation were identified and listed for each facet, which provided a clear documentation of how the facets of a grid image can differ from each other.<sup>9</sup> A complete list of facets is colour, figure/ground, accuracy, orientation, geometry, cell shape, consistency, and background. The facet elements were coloured, black and white, greyscale, embossed, precise, imprecise, linear, curved, consistent, distorted in part, figure, and ground,

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<sup>8</sup> Sol Lewitt's documentation was prodigious and a great inspiration to my research.

<sup>9</sup> I identified the significant parts of the two-dimensional grid that varied in the images I viewed. It would be possible to employ an approach using a random sample of respondents and aggregate (representative) responses could have been calculated that were of greater reliability and validity than the present case study. However, it is not the intention of this research to develop any form of nomothetic measurement but rather to produce initial insight and to develop a mapping sentence that is useful in grid painting.

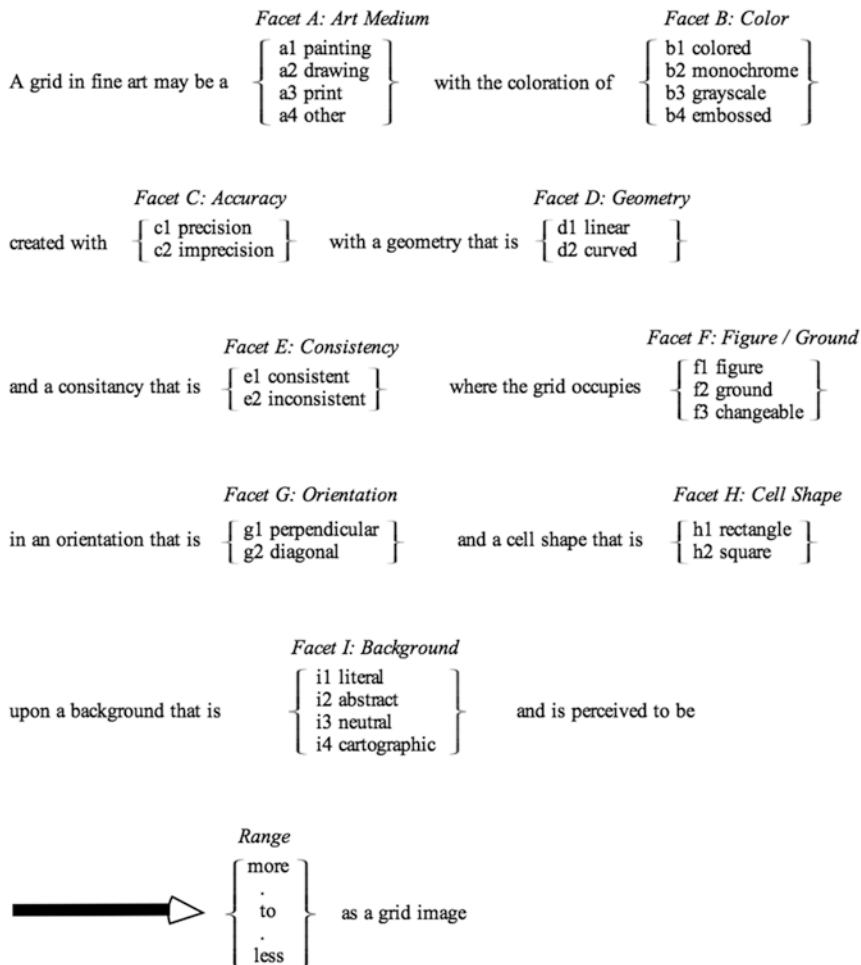
changeable, vertical, diagonal, oblong, square, image, abstract, neutral, and cartographic. This resulted in a mapping sentence for the painted grid (Fig. 4.4):

In both art practice and theorising about grid-based artwork, the mapping sentence definition of grid image variation constitutes a definitive, pragmatic template for understanding and painting art based upon these images. The development of the mapping sentence was the start of extended practice in which I created paintings, drawings and made prints using the mapping sentence to guide my two-dimensional work: The mapping sentence essentially formed an 'explanatory vocabulary' for my grid painting (see Fig. 4.5 for an example of one of my paintings entitled '8033').

Tests of the mapping sentence were undertaken through sketches, which were later worked into more developed and complete pieces, demonstrating how the mapping sentence informed practice-based understanding. Descriptive frameworks were developed for any of my grid images that were based upon all of the facets of the mapping sentence from which I selected one element from each facet for each piece of work (in a process analogous to selecting an element from each facet for each survey question). By using an unambiguous template for my understanding of artistic grid images I was able to experiment and change several aspects of my work whilst maintaining coherent grid perception.<sup>10</sup> In addition to practical explorations, the mapping sentence assisted in exploring aspects of theory: For example, various neuroscience and Gestalt notions such as similarity, proximity and angle of line intersection, axiomatic and abstract of grid image, line doubling to represent diplopia versus perspectival distortions. Using a mapping sentence procedure, I could produce valid, reliable, and unmistakable grid images and later complete grid paintings through which I explored the perceptual complexity of the mapping sentence. There was a further function performed by the mapping sentence as the definition of the complexity of the grid image suggested the enormity of attempting to create a body of

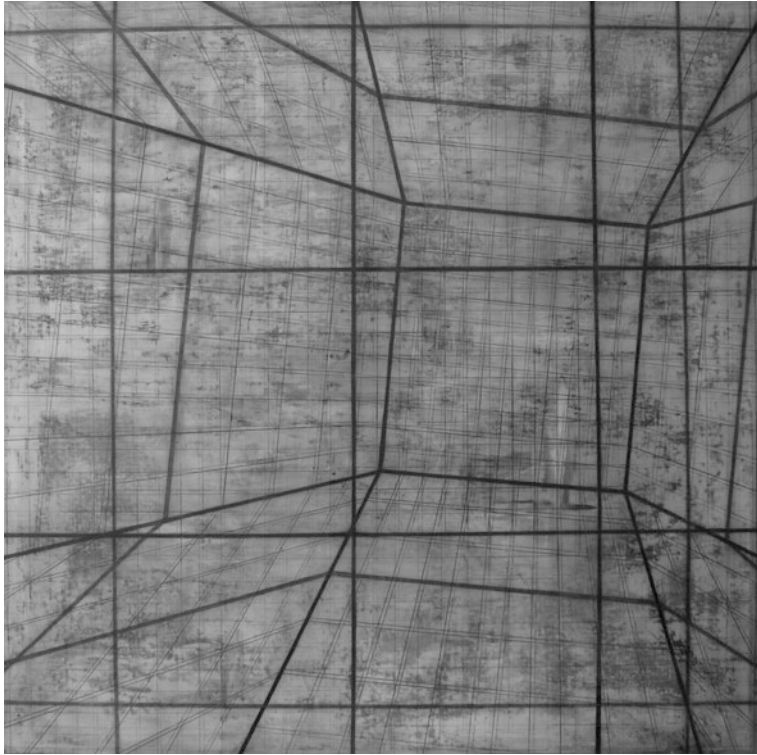
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<sup>10</sup> Other non-image aspects that were considered included: support size and its relationship to grid-cell size, grid line thickness and painting size and how these related to figure-ground tension; the balance between grid and background; the effects of supports (including: canvas, linen, paper, stretchers); medium (paints, powder pigments, glazes, oil colors, alkyds, oil bars).



**Fig. 4.4** Mapping Sentence for Defining Grid Image Variation. ('Reproduced with kind permission of Routledge')

work that was made up to represent all possible combinations of the grid's variable elements. This led to my decision to hold constant some facets (after reviewing literature on grid painting, that is, Albers (2013) I reasoned that I could paint and vary grid images without colour having a major role in effecting reception of the grid's structure). I therefore



**Fig. 4.5** Painting '8033'

rewrote the mapping sentence so that the colour facet had a single element of greyscale. The mapping sentence rather than stultifying my artistic endeavours, defined a 'creative variety' leading me to rigorously reconsider the axiomatic Modernist grid trope, and to question the grid's fixed qualities. This suggested the forms and structures that could be explored and insinuated as to how grid-lines and grid-cells could be crafted in relation to figure and ground qualities. My painting also questioned the representation of normal and impaired vision using the mapping sentence and in order to achieve this I incorporated neuroscientific understanding of diplopia<sup>11</sup> and my studio practice integrated Gestalt

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<sup>11</sup> I identified Lee Allen to have been an artist with visual impairment who had attempted to paint his macular degeneration. His research paintings and subsequent writing were extremely informative in my research.

theory and neuroscience. The research progressed through several stages all of which were informed by the mapping sentence, which I also used to enable coherence within the body of work I produced.

The nine facets I identified in the mapping sentence for defining grid image variation (Fig. 4.6) were identified as influencing both the creation and the perception of fine art grid images. Each of these facets played a specific role (in the sense of facet roles mentioned in this text), independently and together, in designing, making and viewing grid-based art. The facets and their roles are listed in Fig. 4.6.

Facets in the mapping sentence appeared to play axial, polar, and modular roles. The interpretation of these roles and indeed the validation of the mapping sentence came about through an interpretive cycle. In this process, components of the grid were analysed in reference to the grid as a whole and my prior knowledge of facet theory, which cyclically interacted with my painting and my interpretation and understanding of the grid image. The mapping sentence demonstrated its utility in guiding art practice but in the future, this framework could be used to design research, which questioned individuals (both artists and viewers) about how they understand the grid image. This data could be gathered using, for example, Likert scales which would allow smallestspace analysis to be performed and may lead to refinement in the meaningful understanding of the MS and possible joint roles played by facets.

In the research reported above, I used facet theory and a mapping sentence in a manner that allowed me to initiate and use a guide for my artwork. This definitional taxonomy, by exhaustively identifying the variable components in two-dimensional grid-based artworks enabled me to break down my understanding of these images and then to reconstruct them reflecting the instantiation of grid variation and visual impairment. This is a novel use of the mapping sentence in which the data that I gathered to investigate the utility of the mapping sentence came in the form of visual images which confirmed the mappings validity through my resulting paintings aesthetic and theoretical merit. The mapping sentence allowed me to systematically distort the grids I created so that they embodied the perceptual effects of diplopia whilst the images remained



<i>facet</i>	<i>facet name</i>	<i>elements</i>	<i>facet role</i>
A	art medium	a1 painting a2 drawing a3 print a4 other	modular
B	color	b1 colored b2 monochrome b3 grayscale b4 embossed	modular
C	accuracy	c1 precision c2 imprecision	polar
D	geometry	d1 linear d2 curved	axial
E	consistency	e1 consistent e2 inconsistent	polar
F	figure/ground	f1 figure f2 ground f3 changeable	axial

**Fig. 4.6** Facet roles for the mapping sentence for defining grid image variation

G	orientation	g1 perpendicular g2 diagonal	axial
H	cell shape	h1 rectangle h2 square	axial
I	background	i1 literal i2 abstract i3 neutral i4 cartographic	modular

Fig. 4.6 (continued)

grids. By defining the grid's variable components. I permitted myself a clear understanding of the axiomatic grid and how artists had varied grid images yet allowing grids to perceptually endure. To the best of my knowledge, this is the first time in published research, that a mapping sentence has been used to define art images or to guide the creation of art images or objects. It may also be the first research to use visual art as qualitative data within a facet theory rubric. In the following section, I continue my consideration of the use of qualitative data within facet theory.

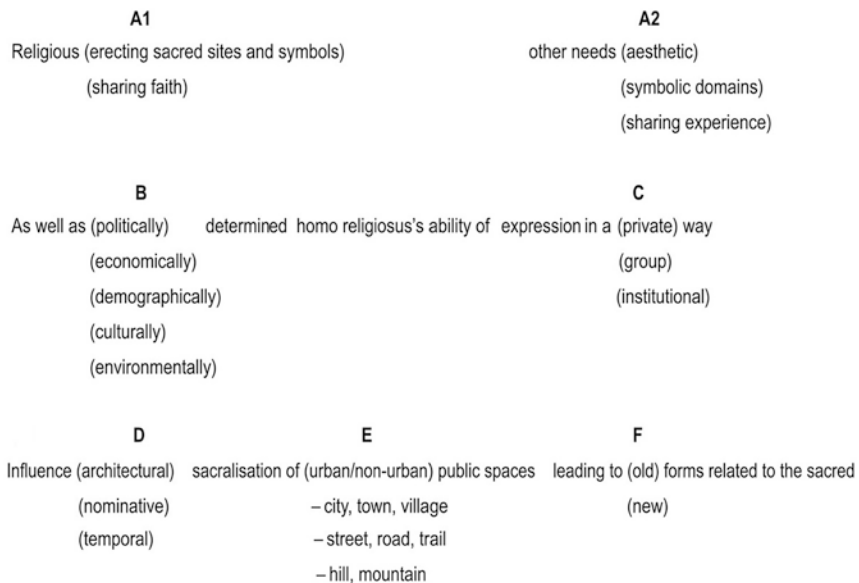
## Religion and the Process of Sacralisation

Lucyna Przybylska provides another example of the use of declarative mapping sentences in her research. She is a geographer who investigated religion and what she calls the process of sacralisation (Przybylska 2014). Her research viewed how religiosity has become an area thought worthy

of the social science’s consideration following on from the dominance of the secular paradigm. Religiosity is now seen to be an important part of public and private life. She considered the literature on how re-emergence of religion is understood and sacred spaces (Bilska-Wodecka 2012; Davie 2013; Havlíček and Hupková 2013; Klima 2011; Soljan 2012; Theije 2012; Zelinsky 2010;) using the Polish city of Gdynia as a case in point.

Przybylska’s analysis identified a series of facets that to account for the visual presence within Gdynia which she linked together in a declarative mapping sentence (Fig. 4.7).

Having proposed the declarative mapping sentence, in order to investigate the visual expression of religion in the city she used a variety of qualitative research approaches, including, field observation, analysis of source documents, analysis and criticism of the bibliography, visual documentation, and participant observation. Przybylska also used the declarative mapping sentence as an interpretative framework for her analysis and in writing-up her research. She stated that her declarative mapping



**Fig. 4.7** A mapping sentence of the process of sacralisation (Przybylska 2014, p. 118)

sentence, “illustrates a kind of model that emphasises different components of the term landscape sacralisation, (and) it can be used to interpret, step by step, the complex phenomenon of visual manifestation of religion in the landscape.” (Przybylska 2014, p. 118). Moreover, the mapping sentence defines sacralization as well as suggesting a way to conduct research into this which enabled Przybylska to address religious needs and the public expression of their faith.

The declarative mapping sentence also facilitated her consideration of both individual expressions of the sacred (C), aspects of sacralisation (D), early and modern forms of the sacred (F) in the context of different space (E). It also allowed her to address in depth the facets of the mapping sentence both in an isolated manner and as they exerted a combined effect and which therefore enabled her research to comprehensively delve into the sacralization process. For Przybylska the declarative mapping sentence was, she claimed, useful as factors and different forms of sacralization could be designated. The declarative mapping sentence, “enables a step by step exploration of different facets of the multidimensional process of landscape sacralisation” (Przybylska 2014, p. 131). She concluded that her declarative mapping sentence was unique in the geography of religion literature in the manner in which it presented the conceptualised the process of sacralization.

## Prison Officers’ Occupational Stress

Sian Blake (2020) employed a declarative mapping sentence in her research into occupational stress in prison officers in England. Blake focused on occupational stress as stress is often comes about due to the interaction and relationship between a work environment and the people who work there. Recent documentation was cited by Blake to indicate that stress, depression and other mental illnesses have been found to be present to a significantly greater extent in prison officers than other occupational groups (Health and Safety Executive 2019; Ministry of Justice 2020). Prisons are especially pertinent as they are noted as being stress inducing settings as they may involve prison officers as being in situations which they find stretch their capacity to cope: In these situations, the

level of stress reaction experienced is dependent of the individual's interpretation of the stressor and their ability to deal with it.

Blake also contextualised Cooper and Marshall's 1976 model of occupational stress with this group of employees. Blake set the scene for her study by noting how prisons are emotionally charged environments that are often thought of as being extremely tough and even dangerous places to work. She also commented how prisoners have programmes in which they may engage in order to help them to cope with emotional and other difficulties they may encounter. However, as a person employed as a prison officer she claims that there is much less formal support for prison officers.<sup>12</sup> Perhaps, in part as a consequence of this lack of support, there is a culture within prison staff that is rooted in what some think of as toxic masculinity and machismo attitudes. The result of such a culture is that prison officers may feel uncomfortable to share their emotional reactions at work. However, research that has been conducted by academics and by the British government has emphasised that it is extremely likely that prison officers experience stress associated with their occupation. This is evidenced, Blake claimed, by levels of sickness that are regularly higher than sickness in the general public with ten working days on average being annually lost to sickness for each prison officer, which contrast with 4.4 days for the average worker in the UK (Blake 2020).

In her research, Blake reviewed the literature on employee stress and discovered Cooper and Marshall's 1976 model of occupational stress. She set herself the question of whether this model could be usefully applied to the stress experienced by prison officers and if it could shed light on the unparalleled levels of stress it is claimed that prison officers experience. Her research took the form of a secondary source review of literature which she analysed and organised within the structure suggested by a declarative mapping sentence (Fig. 4.8).

Her results of this review allowed her to state that the model of occupational stress proposed by Cooper and Marshall (1976) can, to a large extent, be usefully applied to the stress that is experienced by prison officers in their work settings and that Cooper and Marshall's model yielded understanding and insight.

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<sup>12</sup> She speaks with experience about such facilities as she is a serving prison officer.

Prison officer (x) experiences stress within their work in terms of their work being:

*'1/ Organisations structure and climate'*

- ambiguously defined
- clearly defined

in terms of their roles, where they feel stressed due to:

*'2/ Stressors that are intrinsic to the job'*

- poor working conditions
- work overload
- time pressures

in situations in which they feel they operate within a climate of:

*'3/ Role within the organisation'*

**Fig. 4.8** Declarative mapping sentence (DMS) for Cooper and Marshall's model of stress applied to prison officers (Blake [2020](#), p. 25)

- autonomy
- ambiguity
- conflict

and where stress may be influenced by relationship with:

*'4/ Relationships at work'*

- colleagues
- management

along with their concerns about:

*'5/ Career Development'*

- job security
- promotion

**Fig. 4.8** (continued)

Blake developed her declarative mapping sentence by identifying the pertinent aspects of occupational stress that have been discovered using Cooper and Marshall's original model. After analysing the literature however she found that the mapping sentence needed modification through the inclusion of additional facets and the modification of her initial facets.

The experience of stress is a complex phenomenon, especially when a moderate amount of stress may be beneficial in the performance of a task. Blake claimed that her research demonstrated the applicability of Cooper and Marshall's (1976) model of occupational stress, as this is present in prison officers. Stress within an occupational setting is, says Blake, a multi-faceted issue that may be difficult to understand especially as responses to stressful situations as well as the situations that a person finds stressful, may appear idiosyncratic. Her research demonstrated that Cooper and Marshall's (1976) model offered a useful framework for attempting to comprehend prison officers' occupational stress due to the way in which it arranged stress into explicit categories based on occupational, organisational, and individual factors. Cooper and Marshall's model also incorporated a recognition of the previously noted causes within the individual experiencing stress along with occupational role, characteristics of the employing organisation and the interaction of all factors.

In her research, she reviewed the literature on occupational stress in prison officers using a declarative mapping sentence that was based on Cooper and Marshall's (1976) model. She used the declarative mapping sentence's facets and elements a frame within which she thematically analysed the contents of publications. She also included articles in the analysis related to prison officers' stress experiences that were focused upon the interface between their home and work. The discovery of these external stress related features resulted her in amending her initial declarative mapping sentence by including a facet of external conditions (facet 6). She also added two facets that recognised the research that had looked at individual differences using the "big-five personality traits" (openness to experience, conscientiousness, extraversion, agreeableness, neuroticism) (Rothmann and Coetzer 2003) (facet 7a) and locus of control (facet 7b). The modifications are shown in Fig. 4.9.



*'1/ Organisations structure and climate'*

- ambiguously defined
- clearly defined

in terms of their roles, where they feel stressed due to:

*'2/ Stressors that are intrinsic to the job'*

- poor working conditions
  - o workplace safety
- work overload
- time pressures

in situations in which they feel they operate within a climate of:

*'3/ Role within the organisation'*

- autonomy

- ambiguity
- conflict

and where stress may be influenced by relationship with:

*'4/ Relationships at work'*

- colleagues
- management

along with their concerns about:

*'5/ Career Development'*

- job security
- promotion

which are in a feedback loop of influence with:

**Fig. 4.9** (continued)

*'6/ External conditions – (work-home interface)'*

- time-based conflict
- strain-based conflict
- behaviour-based conflict

where the individuals ability to adapt may be influenced by their:

*'7a/ Individual differences 1''*

- extraversion
- agreeableness
- conscientiousness
- neuroticism
- openness to experience

and / or by their having an:

**Fig. 4.9** (continued)

*'7b/ Individual differences 2'*

- internal locus of control
  
- external locus of control

when coping with stress.

**Fig. 4.9** (continued)

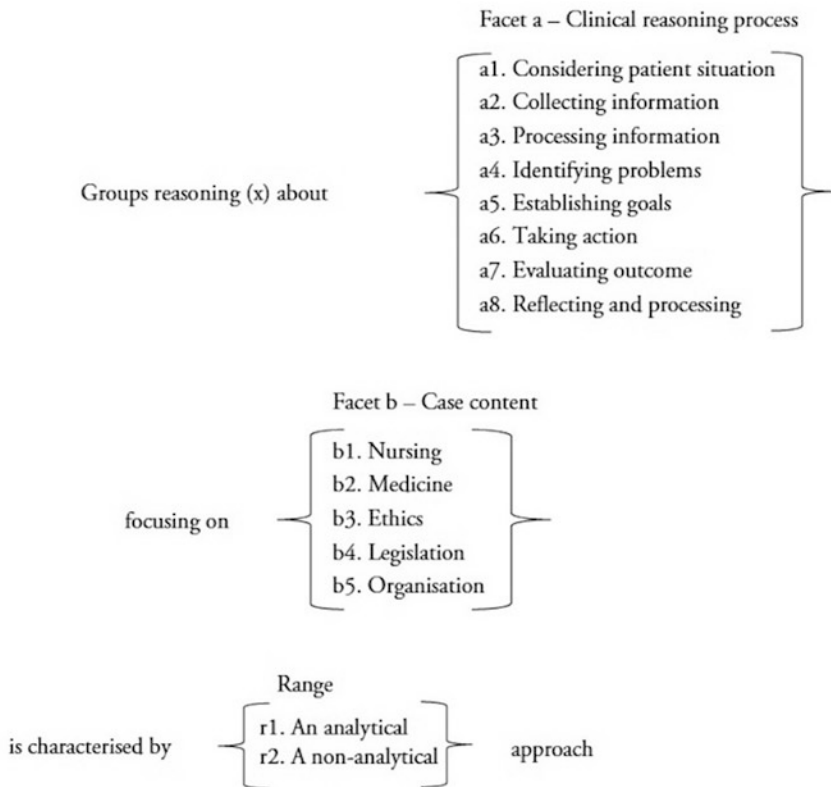
Prison officer (x) experiences stress within their work in terms of their work being:

Blake (2020) noted that the issues of occupational stress in prison officers are systemic issues. In this group of employees, she says, stress results from the combination of actual and perceived structural features of prisons, combined in the manner suggested in the revised mapping sentence. Blake (2020) recognised Cooper and Marshall's model as offering a useful point from which to commence an exploration of prison officer's experiences of occupational stress. Their model, she stated, had limitations and she addressed some of these in her modified mapping sentence, which more completely explained the features that produce occupational stress in prison officers.

However, she also noted that the revisions that she made in Cooper and Marshall's framework needed further amendments and primary research based upon the revised declarative mapping sentence. Examples she cited of revisions included facets that take into account the influence that staff-prisoner relationships can have on prison officers' experiences of stress and the role of gender and other individual differences.

## Characteristics of the Clinical Reasoning Process

Another example of the application of a declarative mapping sentence is provided by the research into the competence and education of ambulance nurses by Jonas Wihlborg et al. (2019). The declarative mapping sentence for this research is shown in Fig. 4.10. The researchers proposed a broad question that bound the scope of their research which was, “what similarities, differences and characteristics of clinical reasoning are found



**Fig. 4.10** Mapping sentence used to explore the characteristics of the clinical reasoning process (Wihlborg et al. 2019, p. 49)

among groups of specialist ambulance nurse students and professional specialist ambulance nurses?” (Wihlborg et al. p. 49).

Before I consider the research by Wihlborg et al. (2019), it is important to note the presence of a range facet in their mapping sentence. Throughout this book, I have said that the range facet is used in traditional mapping sentence in conjunction with quantitative research and not in declarative mapping sentences in qualitative enquiries. This is true but there are exceptions to this statement. Range facets guide and determine the type of research that will be undertaken and specify what will be considered the output or data that will be gathered. This is essential and appropriate when conducting quantitative research. For instance, by stating that the measurements that will be taken in a study will range from 1, which equals very dissatisfied through to 5 which means very satisfied, and that responses will be in the form of 5 possible integers. However, “6”, “452”, “A”, “cat”, or “4.87” and so on, are all unacceptable responses as they are not in the response range. Establishing acceptable responses means that there is no ambiguity in the data gathered and responses may be directly compared and aggregated. Removal of ambiguity in quantitative research allows for confidence to be established in the data gathered and the results that are developed out of the research.

However, qualitative research gathers information from participants, which usually takes the form of an open expression by the participant. As such, it is not appropriate to specify which responses are acceptable and which are not. If a researcher specifies the range facet and thus the responses that are acceptable, in qualitative research he or she is engaging in a restrictive practice. In the case of Wihlborg et al.’s (2019) research, the range facet in the mapping sentence was not used to determine the form of response from respondents but to later classify open responses using a stated protocol.<sup>13</sup> Consequently, the authors included a range facet which incorporated two elements in the form of ‘analytical’ and ‘non-analytical’. It is interesting that Wihlborg and colleagues, rather than labelling their output facet as a response range facet, they named this an organisation range. This is an extremely important point as the facet performed in the role of a post-data gathering protocol for organising

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<sup>13</sup>I briefly commented upon this earlier in this book.

the information present in the open responses that they had amassed and did not require those taking part in the research to provide responses in the form of values in the organisational range. As range-bound responses were not gathered from respondents, this mapping sentence is declarative rather than traditional (Fig. 4.10).

Wihlborg and colleagues' research took the form of a case study (Kim et al. 2006; Mauffette-Leenders et al. 2005). Participants were Swedish ambulance staff who were all registered nurses with training in ambulance nurse education and clinical practice. There were 32 participants in the study, 19 of which were students and 13 were specialist ambulance nurses. All student participants had attended or were attending specialist ambulance nurse training and had different levels of clinical nursing and ambulance care experience.

Participants were all allocated to groups and they all actively participated in discussions, which lasted 30 to 90 minutes, of case stories they were given. Cases were designed for the groups to discuss which included many theoretical and applied aspects of the clinical work that ambulance staff engage in. Open discussions involved the researcher listening actively but only interrupting and interacting with participants occasionally in order to clarify points.

The researchers designed a declarative mapping sentence with two facets that differentiated the substance of the cases. The first facet was of Clinical Reasoning and was composed of eight elements that were incorporated from Levett-Jones et al.'s (2010) principles of clinical reasoning. They used these as elements because they said these reflected the types reasoning to be found in a clinical setting of. The elements were: considering patient situation; collecting information; processing information; identifying problems; establishing goals; taking action; evaluating outcomes; reflecting and processing. Their second facet was made up of five elements that accounted for 'case content', with the five elements being nursing, medicine, ethics, legislation, and organisation. They incorporated this facet and its elements into the declarative mapping sentence so as to enable the identification of the different settings in which respondents' employed reasoning. The element of nursing embodied nursing's cardinal central properties (Ekman et al. 2011; Henderson 1991) and the second element incorporated medical aspects of their work. Elements

three to five were characteristics of their work associated with reasoning. As I mentioned earlier, the range facet was used to organise data into two elements dependent upon it employing either an *analytical approach* or *non-analytical approach*,<sup>14</sup> where these two approaches were derived from accounts of clinical reasoning in the literature (e.g., Durning et al. 2015; Eva 2005; Marcum 2012). An argument can also be made for this range facet actually being a content facet. The researchers transcribed the discussions and the declarative mapping sentence was used to perform an analysis of the discussions' contents.

The authors claimed that their results revealed the declarative mapping sentence they used in their research offered a structure within which to analyse and identify characteristics of the reasoning that was used by ambulance staff. The mapping sentence also facilitated variation in the configurations of reasoning elements between the different respondent groups. The first student group fluctuated between analytical and non-analytical reasoning regardless of content or process. The group became somewhat more analytical if they were reasoning about nursing and medicine. The group also focused on medicine and nursing but considered ethics and legislation less. The group directed a small amount of their reasoning on information collection and rarely on reflection and processing. The second student group's reasoning was both analytical and non-analytical with most reasoning being about nursing and a large amount of reasoning was about organisation and medicine, with little directed towards legislation. This group directed their reasoning towards all elements of the Clinical Reasoning facet; however, collecting information, reflecting, and processing were infrequent targets of their reasoning.

In their article, the authors went on to draw similarities and differences between the two groups and made especial note that ethics and legislation issues were least discussed and information collection was discussed less than evaluation, reflection and processing. In all groups' participants' focus was on applied considerations and mostly on evaluation and least on collecting information. Moreover, the student group tended to use

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<sup>14</sup>The researchers wished to quantify responses and they therefore assigned each unit of reasoning they discovered as being either analytic or non-analytic based on the depth of knowledge participants employed in completing a specific item during the groups' discussions.



analytical reasoning and processed information more than those in the professional group.

In conclusion, a declarative mapping sentence was used in the research by Wihlborg et al. (2019) to design and analyse a qualitative study which they later transformed to a what may be considered to be a quantitative analysis. Using the declarative mapping sentence, they were able to establish configurations of activities within groups of ambulance staff in Sweden and to allow differences and similarities to be identified between students and trained nurses in terms of the declarative mapping sentence's facets and elements.

## Black Lives Matter

The next brief example of the use of a declarative mapping sentence is by Hackett and Schwarzenbach (2020). In their mapping sentence, they responded to the rightful outrage of many people towards the murder of the black man, George Floyd, by a white police officer in Minneapolis and the vitriolic attack upon the black bird watcher, Christian Cooper, by a white woman in Central Park, New York.

In the United States, as well as in many other countries, racism is rampant. There seemed to be a peak in racial atrocities towards the end of May 2020. This crescendo included the murder by a white male police officer of the unarmed black man George Floyd in Minneapolis, and the verbal attack in Central Park, New York, by a white woman on a black male bird watcher, Christian Cooper. In the George Floyd killing, a crowd looked on as he died after he had been arrested for spending an allegedly counterfeit 20-dollar bill. Christian Cooper filmed a woman calling the police to report an African American was threatening her life. When the police arrived, it was apparent that Cooper was doing no such thing and the incident was widely shared on social media as yet another racist action.

In their writing Hackett and Schwarzenbach (2020) considered the impact of these and other racially motivated events specifically upon the practice of ethnographic research. These authors first reviewed how the health and well-being of those from minority groups were affected by

racism and how these disadvantages put them in a worse position in terms of COVID-19 where Black Americans account for almost one in four Covid deaths whilst constituting only one in eight of the US population. Even in the presence of the ongoing Black-Lives-Matter movement, the chapter by Hackett and Schwarzenbach was added to a textbook on ethnography and as an after-thought, and only after the two attacks mentioned above. The authors claimed this reflected how racial issues are often neglected in our considerations of the research process and in the disseminators of knowledge and that the possibly detrimental preconceptions that are held need to be unacknowledged and addressed through “bracketing” from the start and during a research project or publication. Indeed, they bracketed the contents of their writing in terms of its inevitable inherent biases and preconceptions.

Hackett and Schwarzenbach (2020) developed a declarative mapping sentence for understanding acts of racism. In order to formulate this mapping sentence, the authors considered many aspects of what we may call racism, along with other forms of overt and covert human activity. They started by noting how racism, like other catastrophic events, is often ignored until some terrible event occurs and how in America, have not made necessary social and individual changes in order to avoid this happening. They also noted how, over the past decades, many necessary changes have been made in regard to the language that is used when speaking about people of colour but that these changes have not been accompanied by other substantial changes, for example in policing practice, incarceration rates, life opportunities for people of colour, and so on. Jessica Schwarzenbach and I also reflected upon some of our own experiences and the privileged status we occupy as white people. For example, I am a white bird watcher and I have never found myself in the position of Christian Cooper. Indeed, I do not have to consider that someone may see me with a pair of binoculars and report me to the police, in the way a person of colour does.

Having considered some of these and other background details, the authors resisted listing the egregious ways in which people of colour may be treated and instead attempted to identify the variety of ways an ethnographer can address racism. This led to the development of the declarative mapping sentence for understanding acts of racism (Fig. 4.11).

A specific person or group of people (x) commit the:

**Intent**

(intentional )

(unintentional )

(unthinking )

**Type of action**

(verbal )

(physical )

(mixed )

racist act, which is targeted against:

**Target**

(an individual )

(specific group)

(wider culture )

and has the consequence of causing:

**Consequence**

**Fig. 4.11** Declarative mapping sentence for understanding acts of racism.  
(Reformatted from: Hackett and Schwarzenbach 2020)

(death )

(physical injury )

(psychological injury )

(mixture of the above )

(social segregation/unrest )

to a person or persons, and which is perceived by a person who is:

**Person viewing**

(Black )

(not Black )

**Fig. 4.11** (continued)

The declarative mapping sentence in Fig. 4.11 embodies the initial thoughts of the authors in terms of the pertinent aspects of a racist action. It is an initial template that qualitative researchers can use to design research into racism and the consequences of these acts. The facets denote the main types of racism that the authors consider to be important when designing or interpreting qualitative research that addresses racism. These specify the racist action in terms of these being the perpetrator's intent, the type of racist action committed, the target of the racist action, the consequence of the action, and also, who is viewing or interpreting an act of racism.

In the mapping sentence, it can be seen that the mapping sentence specifies that acts of racism may be understood in terms of:

- whether they are undertaken by either groups or individuals by people;

- the actions which are committed (verbal, physical, or acts that are a mixture of these);
- the intention behind such an act (intentional, unintentional, or unthinking);
- the person or persons against whom the act is targeted (individuals, specific groups, or wider culture groups);
- the action's consequences: (death, physical injury, psychological injury, a mixture of these, and social segregation/unrest);
- the person viewing and interpreting the action (black or not black).

The mapping sentence will need to be adapted to meet the needs of each specific research project through the adaptation, deletion, and addition of facet elements. The authors believed that by using the mapping sentence will help researchers when designing of research into racist actions by listing the forms of racist activities and by providing a framework within which to design research instruments. The authors concluded by stating that this was an initial proposition for the content of the declarative mapping sentence which would inevitably change through use.

## **Attitudes Towards Different Forms of Transportation**

Travelling is an inevitable part of our lives. Some may find this enjoyable in a variety of contexts, whilst in a different situation they may find travelling a chore. Golam Morshed is a transportation researcher from the Technische Universität München. In his ongoing research, he has used declarative mapping sentences to design and understand a variety of aspects of transportation related behaviours.

One of the projects Morshed is concerned with looks at what we do whilst we are travelling. For example, when we are travelling we often engage in an activity that is not associated with driving. Examples of these include gazing out of the window, listening to radio or other forms of pre-recorded music, reading by in a wide variety of formats from books

and papers to electronic devices, eating, drinking, or even sleeping. Furthermore, we can engage in activities in isolation or in a variety of combinations, such as eating, drinking, and listening to music at the same time (G. Morshed, Personal Communication, 2020). Morshed noted also that the types of activities with which we engage are individualistic and also vary dependent upon who we are travelling with (family, friends, colleagues, etc.). What activities we engage in will also vary related to the modality of transport we are using. Examples he provided included the ability to sleep only if you are not driving and are taking, for example, some form of public transport. The author then notes how all activities take time to commit and that timers can be thought of as belonging to one of the following categories or types: contracted time, committed time, necessary time, and free time. Furthermore, each activity may be classified as belonging to a specific class of activity, namely, mandatory activity, maintenance activity, or discretionary activity. What we do whilst we travel also vary in terms of what they achieve. For instance, some of the things we do may be work related and may perhaps also increase our productivity. However, other activities may not be productive but simply enjoyable or relaxing (such as gazing out of a window).

When he conducted a literature search, Morshed discovered that over the last 20 years a large literature and number of research projects that have been undertaken on this topic. However, he was unable to find a clear and unambiguous definition in any of this research regarding what constituted a travel-based secondary activity. Morshed (Personal Communication, 2020) therefore used existing research in order to develop a declarative mapping sentence for secondary activities during travel (Fig. 4.12).

Secondary activities during the travel:



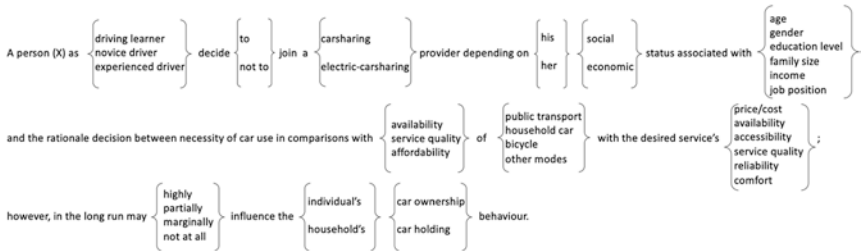
**Fig. 4.12** Declarative mapping sentence for secondary activities during travel

In the declarative mapping sentence for secondary activities during travel Morshed has incorporated all of the aspects discussed above in the form of a sentence that suggests the relationship between these.

In another study, Morshed investigates the transportation activity of car sharing. Morshed (Personal Communication, 2020) comments upon the large number of studies that have been conducted into car sharing in the USA and in other countries. He notes that car sharing has advantages such as the potential to very significantly reduce car ownership and the number of cars on the road and that little of the literature concentrates upon young drivers between the ages of 18 and 35. Thus, amongst drivers of this age relatively little is known regarding their attitude towards the practice of car sharing. Furthermore, Morshed discovered no studies that specifically investigated car sharing attitudes in current learner drivers who were attending driving schools or the holders of temporary driving licenses. Examples of temporary licenses include those available to young people of 17 years of age in Austria and in Britain where you can apply for a provisional (learners) license at the age of 15 years 9 months and start driving at 17. Restrictions apply to these and similar licenses such as having to be accompanied in the car by a person who has a full driving license. Furthermore, in Austria, all new licenses are temporary during the first year during which they must practice and at the end of the year, the new driver must pass two tests of driving.<sup>15</sup> Not all the current learner and temporary driving license holders have a car that is available to them and they have to hire a car in order to attain driving practise. As an alternative to renting a car, they may engage in car sharing. Renting a car in Austria, and many other countries, is relatively expensive, especially for young people. However, the alternative, car sharing, has the problem of availability and accessing a shared car a problem exacerbated by not all towns and cities having a car sharing facility or at least one that is available to temporary license holders. As a consequence, young drivers may attempt to afford to purchase a car and once they have become used to owning a car they may find it difficult to take what may feel like a step backwards and become a car sharer. Morshed (Personal Communication, 2020) therefore developed a declarative mapping sentence to encapsulate

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<sup>15</sup> These and similar rules vary from country to country.

Driver's decisions to join carsharing service:

**Fig. 4.13** Declarative mapping sentence for features influential in decisions to join a car sharing service

the criteria and factors that may impinge upon a person's decision to car share in Austria (see Fig. 4.13).

As can be seen, this mapping sentence is complex as there are many factors that Morshed found influential in car sharing decisions for Austrians. However, he discovered the utility of the declarative to provide a framework for his ongoing research in this area.

## Using Information Technology

The final example I will present of the use of a declarative mapping sentence is of study that Zhang et al. (2016) carried out into the use of constructs in research. This is a very different type of illustration both in terms of the subject matter of its application and it having a heavily theoretical foundation. These authors started by claiming the importance of using clearly defined constructs in research and concentrated on the area of users' reactions to information technology. As a background to their research, Zhang et al. (2016) stated how the choice of the research approach chosen by a scholar was associated with whether they held either a constructivist or positivist perspective. Constructivists understand the world to be an uncertain place in which people are seen to largely construct their experiences and their understanding of these. Positivists, on the other hand, see the world as being much more a concrete place which we can discover through careful observation. Zhang,



et al., note how the positivist–constructivist dimension has a large effect upon the type of constructs we employ and the degree of clarity we expect them to have. In their writing, they claim a position between these two poles as being the one they adopt.

The authors then go on to consider constructivism and positivism and associate this with facet theory and the use of mapping sentences. A positivist orientation may, they claim, be reflected in an expectation in the ability for a construct to be predictive of observations in the situation of the research and beyond. Conversely, holding a constructivist perspective may imply that a construct is simply a label for a phenomenon within a specific context and that this is unlikely to transfer to other situations. The authors then delve deeper into how important it is that concepts in research are rooted in clearly defined constructs. Facet theory has typically been used as a quantitative measurement and technique in the context of empirical research (McGrath 1968, 1984; Lange 2008). However, Zhang et al. (2016) believe facet theory's core value to be its implicit logic, and they fix their attention upon using facet theory to aid in the development of clear constructs along with how it is used in conceptualisation. Zhang and colleagues believe that theories are built using constructs as building materials (Weber 2012). In my writing in Hackett (2020b) I noted how Zhang et al.'s (2016) understanding that researchers articulate who use conceptualisations to define and put limits around abstract concepts (Kaplan 1964) and that in these situations conceptualisations specify the constructs meaning (Schwab 1980). They also place an emphasis on the need for appropriately specified and used concepts that have been developed with precision (Klein and Delery 2012; Locke 2012; Osigweh Yg 1989; Skilton 2011; Yaniv 2011) which permit the understanding of the bounds of a construct (Weber 2012). Zhang, et al. continue by stressing how the facet theory methodology provides a logical perspective that helps in establishing clear conceptualisations of research constructs and allows a visualisation of the interrelation between concepts. This, they say, propels the researcher towards using clear concepts. They also emphasise how it is important to determine clear and precise grounds that will be used to allow comparison and contrast between constructs.

Later, in their own research, Zhang and colleague viewed literature on IT user's satisfaction and noted that much had been written on construct

validity (e.g., MacKenzie et al. 2011; Petter et al. 2007; Straub et al. 2004; Suddaby 2010) but they concentrated on the need for constructs to be clearly defined, noting a paucity of literature on this. Because of this lacking, Zhang et al. (2016) decided to look at facet theory (Guttman 1954a; Guttman 1954b) and they make reference to the assertions by Guttman (1971) that he developed facet theory to allow clarity in definitions associated with research in the form of a mapping sentence: the approach which Zhang et al. (2016) adopted, using a declarative form of a mapping sentence to explore conceptual items associated with this content. After searching the literature, they noted how user satisfaction (Wixom and Todd 2005), user information satisfaction (Ives et al. 1983), and end-user computing satisfaction (Doll and Torkzadeh 1988) were central to the concept. They included these aspects of IT users' satisfaction as facets within what in essence was a declarative mapping sentence as it did not include a range facet and which also did not have any connective ontology (this is presented in Table 4.1 below).

Based upon the IT satisfaction literature, the authors specified two facets, those of evaluative target and evaluative response. The first facet was of possible the ways in which a reaction may be expressed in relation to satisfaction with IT. This expression facet had the elements of attitude or a belief. The second of their facets contained three different targets to which satisfaction to which a user may have satisfaction within IT. The elements of this facet were information system and computer application. The authors stated that their facets formed a definition, simplified in order to illustrate the ability of their approach but that could have included other facets. However, they saw their mapping sentence as a clear statement of their conceptualisation of the concept of satisfaction with IT.

**Table 4.1** Zhang et al.'s facets and elements (Zhang et al. 2016)

Facet	User Satisfaction	User Information Satisfaction	End-User Computing Satisfaction
A: Evaluative Response	A[1]: Attitude	A[2]: Belief	A[1]: Attitude
B: Evaluative Target	B[1]: Information System	B[1]: Information System	B[2]: Computer Application

In Hackett (2020b), I incorporated the facets and their elements from Table 4.1 and formed a declarative mapping sentence for IT satisfaction (Fig. 4.14) by combining elements from the two facets Zhang and colleagues (2016) were able to depict satisfaction with IT in a comprehensive manner in terms of different expressions of satisfaction in terms of either user information satisfaction or end-user computing satisfaction.

Zhang et al. believed that theirs was a valid and useful definitional system as through the selection of element pairing their mapping sentence allowed the classification of all events that fall within the concept of IT satisfaction.<sup>16</sup> However, Zhang et al. went on beyond simply stating that their classification system was valuable and evaluated this against the seven principles or requirements that must be met by a classification system offered by McGrath (1968). Zhang et al. (2016, p. 9) stated these requirements to be: (1) Concepts in a content universe should be specified in terms of all relevant facets; (2): The facets, collectively, should be logically exhaustive of the content universe; (3) The logical relationships among facets should be specified; independence among facets is

	Facet A		Facet B
	Evaluative Response		Evaluative Target
The satisfaction of user (x) may be characterised in terms of their:	A(1) Attitude	towards	B(1) Information System
	A(2) Belief	a:	B(2) Computer Application

**Fig. 4.14** Declarative mapping sentence (Hackett 2020b)

<sup>16</sup> See: Shye and Elizur 1994; Hackett 2014a; Hans et al. 1985; Levy 1990, for details of how a concept may be defined using a mapping sentence and its structuples.

preferred; (4) Each facet should be analysed into a set of collectively exhaustive (6) The logical relationships among elements of a facet should be specified; (7) The relationships among the concepts defined according to the facets and the elements of facets should correspond to the focal phenomenon. By evaluating their declarative mapping sentence along the above criteria Zhang and colleagues found it to fulfil the requirements for being a valuable approach to classification.

## Conclusions

In my continuing research, I have been developing and refining the declarative mapping sentence for several years. My aim in undertaking this work has been to advance a research tool that is flexible and applicable within a wide variety of qualitative and philosophical research contexts. In this chapter, I have given details of some of the situations in which both I, and other researchers using the declarative mapping sentence, have applied this in the design and execution of their research. The illustrations I have included have demonstrated the width and diversity of contexts within which the declarative mapping sentence has been usefully used. My selective review has demonstrated that the mapping sentence can be used within qualitative and philosophical investigations in order to engender knowledge in regard of the phenomenon that is being investigated. This is especially the case when the research is concerned with complex behaviours, events, states of affairs, and so on, and in cases where it would be inappropriate to state an outcome variable and I have suggested that the declarative mapping sentence has a value in the design and interpretation of qualitative research. In Chap. 5 I will present an example of the use of the traditional mapping sentence applied to a novel area of research: avian cognition and behaviour.

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# 5

## Facet Theory Research Into Avian Cognition and Behaviour

**Abstract** In this chapter, I return to considering the traditional mapping sentence. The reason for my positioning this writing at this point and not in earlier chapters that took the traditional mapping sentence as their subject is because of the novelty of the application of the approach to investigate avian cognition and behaviour. My colleagues and I conducted the research I report (Hackett et al., *International Journal of Comparative Psychology*, 32, 2019) in which a re-analysis of a previously gathered set of data (Shaw et al., *Animal Behaviour*, 109, 101–111, 2016) was undertaken using a facet theory and mapping sentence approach. In the initial 2016 research conducted by Shaw and colleagues, a test-battery for avian intelligence was developed and administered to a group of New Zealand Robins (*Petroica longipes*). The data they gathered was analysed using principle component analysis (PCA). Hackett et al. (2019) used this data to facilitate analysis using traditional quantitative facet theory and its associated statistical techniques of Smallestspace Analysis (SSA) and Partial Order Scalogram Analysis (POSA). Based upon the results of these analyses, Hackett, et al., formulated a traditional mapping sentence for avian cognition and extended the understanding of the original analysis by Shaw et al. (2016) through identifying two facets with an

interactive relationship specified in a mapping sentence. Hackett et al. (2019) suggested that this mapping sentence constituted a framework within which research into avian cognition may be designed, conducted, and interpreted and that the mapping sentence may be adapted and applied to analogous areas of animal behaviour.

**Keywords** Avian cognition • Avian behaviour • Animal behaviour • Facet theory • Mapping sentences

## Introduction

When a psychologist is interested in measuring the cognitive performance of an individual child or adult, they use a standardised psychometric test battery. There are a large number of intelligence tests ranging from comprehensive assessment batteries that measure a dozen or so types of performance to more focused assessment tests. Tests of general or overall human intelligence are usually formed through the combination or aggregation of sub-test performances. Cognition sub-tests are named to reflect what type of performance sub-tests measures. For example, the Stanford–Binet Intelligence Scale (fifth edition) tests cognitive ability and intelligence. The test has sub-tests some of which are verbal whilst others are non-verbal and has a five-factor structure. The list of five factors (given in italics) is as follows, with the individual sub-tests that comprise each factor given in parentheses: *quantitative reasoning* (non-verbal quantitative reasoning [non-verbal], verbal quantitative reasoning); *working memory* (delayed response [non-verbal], block span [non-verbal], memory for sentences, last word); *knowledge* (vocabulary, procedural knowledge [non-verbal], picture absurdities [non-verbal]); *visual-spatial processing* (form board and form patterns [non-verbal], position and direction); *fluid reasoning* (early reasoning, verbal absurdities, verbal analogies, object series matrices [non-verbal]).

Psychometric tests of intelligence, like the Stanford Binet shown above, yield two forms of information. First, they create an index or score for performance on each of the sub-tests. Secondly, a composite score may be

produced that aggregates, or in some other way brings together all the sub-test scores into an overall intelligence performance quotient. As with other tests of intelligence, the Stanford-Binet test claims to measure more than the individual abilities required in each sub-test execution. General intelligence is a less specific form of intellectual ability which has been found to be the first and strongest factor to be present in factor analysis of many intellectual test batteries. Claims for a General intelligence factor are rooted in the discovery that an individual's test scores of diverse cognitive skills correlate positively with the other sub-tests. The so-called g factor is an important component in the psychometric assessment and understanding of intelligence and has been found to represent over 40% of total variance in the scores within intelligence test batteries. As with tests used to assess human intelligence, claims have been made for the existence of an overall or g factor in the intellectual performance of non-human animal species (Galsworthy et al. 2005; Isden et al. 2013; Matzel et al. 2003).

## Introduction to Avian Intelligence

Pepperberg (1999) noted how the, “cognitive and social capacities of primates have been studied extensively” which is a claim that has also made by others (e.g., de Waal 1989; Byrne 1995; Tomasello and Call 1997) However, there has been a growth in interest in avian cognition (e.g., Cauchard et al. 2013; Cole et al. 2012; Isden et al. 2013; Keagy et al. 2009, 2011) and parallels have been drawn between the cognitive capacities of avian and primate species (Marler 1996).

Avian ability has also been called avian intelligence, avian cognition, and by several other names that indicate a narrower understanding of such facilities. The intellectual abilities that birds possess have been investigated in a number of bird species. For example, corvids (birds from the crow family) have often been the focus of this research, such as Eurasian Jays (see e.g., Cheke et al. 2011; Clayton and Krebs 1994a, b; Clayton et al. 1996; Legg and Clayton 2014; Legg et al. 2016; Logan et al. 2012, 2013; Ostojic et al. 2013, 2014, 2016; Shaw and Clayton 2012; Shaw and Clayton 2013), Rooks (see e.g., Cheke et al. 2011; Jolles et al. 2013;

Logan et al. 2012, 2013; Reid 1982; Seed et al. 2006, 2007, 2008; Tebbich et al. 2007; Zucca et al. 2007) and Federspiel (2010). As can be seen above, there are very many studies into avian cognition and corvids are just one example of a family of birds that has received attention. One of the reasons for corvids being investigated by Shaw et al. (2016) was that Corvids are a family of birds who cache food and therefore, “our expectation was that robins would perform well at memorizing spatial locations.” (Shaw et al. 2016, p. 109).<sup>1</sup>

However, whatever we call a bird’s cognitive, reasoning, thinking, and so on, the behaviours that should be considered to be indicative of avian intelligence, remain uncertain. This lack of clarity in defining avian intelligence is demonstrated in the scarcity of standardised tests for avian cognitive abilities and the paucity of avian psychometric research (see, Thornton et al. 2014 for an example of avian psychometric research).

When assessing human cognition the researcher is able to administer paper and pencil tests (or the computer-based equivalent) that are capable of measuring a wide variety of mental or reasoning abilities. But when attempting to facilitate a greater understanding of avian cognitive behaviours, proxy measures are needed for intelligence as the researcher is unable to administer such tests to birds and is also not in a position to ask questions and receive answers from birds. In addition to this limitation, researchers are also unable to provide instructions for test completion when birds are the subjects. Consequently, when a researcher is attempting to evaluate and understand avian intelligence and other differences in the psychological make-up of birds, they have to observe overt behaviours and infer intelligence and psychological difference from what they see. There are many obvious and other less apparent difficulties associated with measuring a variety of behaviours that are associated with intelligence in animals. One of these concerns is, as I have already noted, the apparent lacking in published research conducted to assess the

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<sup>1</sup> Clayton and Emery (2005, p. R80) note that there is another reason for scientists taking an interest in corvids as, “corvids have the largest brains for their body size of any bird. Perhaps most surprisingly, the crow brain is the same relative size as the chimpanzee brain.” Additionally, young corvids have a protracted period of skill learning from their parents prior to gaining their independence. Furthermore, many species of corvids live in intricate social groups and feed co-operatively all of which provides extensive opportunity to learn from other group members.



conceptual understanding and delimiting definitions of avian intelligence, its associated behaviour, and how this may be broken-down into sub-categories of performance. Moreover, Shaw et al. (2016) discovered an almost total absence of a clearly established literature on avian psychometrics that laid forth ways in which avian intelligence may be measured using procedures that were conceptually coherent, rigorous, replicable, reliable, and valid.

Behaviours have appeared in the avian intelligence literature that are indicative of different forms of avian intelligence, such as perspective taking; co-operative problem solving; creating novel tools to solve specific problems; using working memory; fluid reasoning; visual comprehension; experience projection; visual spatial ability; processing speed; and others. These are all relatively uncontroversial indicators of intelligence. Other examples could have perhaps have chosen but these indicate the variation and breadth of indicators of intelligence that are used.

Shaw and her colleagues (2016) developed a six sub-test cognitive performance test battery which they then used upon a sample of New Zealand robins (*Petroica longipes*). The sub-tests were essentially six tasks ((1) motor task; (2) colour discrimination; (3) colour reversal; (4) spatial memory; (5) inhibitory control; (6) symbol discrimination), which the birds performed. In the footnotes, I provide brief details of the procedure they used.<sup>2</sup>

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<sup>2</sup> In the motor task robins were trained, through the shaping of existing behaviour, to flip a foraging grid to retrieve mealworms. Success was deemed to have happened after three or more mealworms were retrieved in six of seven consecutive trials within three minutes. Colour preference and colour discrimination were measures again using a foraging grid. The bird was presented with a foraging grid that had two of the wells each covered with a different coloured lid. Birds were allowed to flip both lids to discover the reward that was beneath one lid. The well under the lid that was not flipped first was then baited and the birds were allowed to flip one lid before the test was removed. The test was limited to two minutes with a minute between trials with 2 min to complete a trial, with a 1–3 min delay between trials. They pseudorandly chose the well to bait but made sure that one well never contained the bait on more than three consecutive trials. The day after a bird solved the colour discrimination task they were given the colour reversal task to perform, which was the same as the colour reversal task but with the lid that hid the reward reversed. The spatial memory task that was used was simplified and shortened version of a protocol used by other researchers with other species of birds (e.g., western scrub-jays, *Aphelocoma californica*: Pravosudov et al. 2005; zebra finches: Sanford and Clayton 2008; song sparrows: Sewall et al. 2013). Robins were presented with two adjacently positioned foraging grids. Grey lids were placed over 8 of the 12 wells and the corner wells were kept empty with a single covered well containing a reward. On day one the birds were allowed to flip all of the lids to locate the reward. The apparatus was then removed

The results were analysed using a series of statistical procedures and included a factor analytic procedure to investigate if a single factor could account for variation in individual performances across the tasks. They therefore conducted a principal component analysis (PCA) with an unrotated factor solution. Using this procedure the first unrotated principal component has been seen to be indicative of general intelligence (a *g* factor) in both human animals and non-human animals (e.g., Isden et al. 2013; Locurto et al. 2003; Plomin 2001; Plomin and Spinath 2002) with the first component loading being between 30 and 45% of variance in test performance (e.g., Galsworthy et al. 2005; Isden et al. 2013; Matzel et al. 2003).

The PCA conducted by Shaw et al. (2016) produced two components with eigenvalues of greater than unity.<sup>3</sup> The first component explained 34.46% of the total variance with all tasks loading positively upon this. It should be noted that for motor task and symbol discrimination task the loading was weak but that both tasks loaded positively on the second component, which explained a further 24.44% of the variance (see Table 5.1). In their analyses, they found no evidence for the birds having managed to learn the pertinent spatial cues in the spatial memory task and they questioned the informativeness of this task as a cognitive measure.

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and the procedure repeated with the worm placed under the same lid. As with the first trial the birds were allowed to flip all of the lids. The next day, and the day following that, the grids were presented to the birds in the same location, in the same orientation, and with the same well baited. The robins were required to flip all lids and success was measured by the number of lids flipped before rewards were attained. In the inhibitory control task, required the inhibition a pre-potent response. In their task a clear plastic tube was used that was open at both ends (5 cm length, 4 cm diameter, 0.1 cm thickness) and glued to a wooden base. The birds had to go through habituation and training during which the cylinder had its sides blacked out but the ends remained open and a meal worm was positioned in the middle of the tube. Successful habituation was assessed to be meal retrieval within two minutes on three consecutive trials. Training followed a similar path but required the bird to perform the task without first pecking at the tube on in four consecutive trials. There were several other features of the testing procedure than were controlled but I will not include those here (this is the case throughout my reporting of this research). When the testing phase was undertaken the transparent tube was used which was again open at both ends. Success was measured as a bird proceeding (in six of seven consecutive trials) directly to one of the open ends to retrieve the reward without first pecking at the transparent tube and was measured in terms of the number of attempts taken to attain this criterion. The final task was that of symbol discrimination. This involved the same procedure as in the colour discrimination task but involved a choice between a cross symbol and a square rather than lid colour.

<sup>3</sup> A commonly used criteria to establish the number of significant factors or components.

**Table 5.1** Principal component loadings (adapted from Shaw et al. (2016))

Sub-test	PC1	PC2
Spatial memory (4)	<b>0.727</b>	0.184
Inhibition (5)	<b>0.695</b>	0.333
Colour discrimination (2)	<b>0.660</b>	0.084
Colour reversal (3)	<b>0.631</b>	0.274
Motor task (1)	0.231	<b>0.887</b>
Symbol discrimination (6)	0.411	<b>0.673</b>
<i>Eigenvalue</i>	<i>2.067</i>	<i>1.466</i>
<i>% Variance explained</i>	<i>34.46</i>	<i>24.44</i>

Emboldened text highlights loadings over 0.6

Text in italics shows eigenvalues and variance

In Table 5.1 the numbers given in parentheses are the order in which the tests were given in the original research and the numbers on the SSA and POSA plots (these appear later in this chapter). In Table 5.1 the order of tasks (sub-tests) has been arranged by their loading on the two principal components and loadings above 0.6 have been highlighted (copying how Shaw et al. (2016) reported this data).

## Using a Mapping Sentence and Facet Theory to Analyse Bird Performance

As can be seen in the results presented above, avian cognition is a complex phenomenon as is its assessment (Baciadonna et al. 2020). As a starting point in their re-analysis of Shaw and colleagues data, Hackett et al. (2019) decided to take both of Shaw et al.'s principal components and to incorporate these within a facet theory based re-analysis of their data.<sup>4</sup> The questions Shaw et al. (2016) addressed were, “What is the structure of avian intelligence?” and “does a general factor exist in avian intelligence?” The research by Hackett et al. (2019) asked similar questions about the multi-dimensional structure of avian intelligence and intelligent behaviour. Some of the reasons for their re-evaluation of the Shaw's

<sup>4</sup>The value of re-analysing research findings that have arisen from principle component analysis is supported by researchers such as Guttman and Levy [33].

data were because Hackett et al. (2019) expressed concerns over the assumptions of the data that is being analysed that underlie the use of PCA to analyse tests of avian cognition. An example of these potential issues include: a correspondence is needed between data and psychological shapes such that a linear structure is not imposed upon a psychological construct that is experienced as curvy-linear or in some other format; that scales used on different sub-tests are strictly comparable; that orthogonal rotation of constructs is performed upon entities with psychologically independent experiential meaning; that the PCA procedure embodies the meaningful relationships between the constructs in an analysis and the relationship between constructs and the overall psychological domain being investigated.

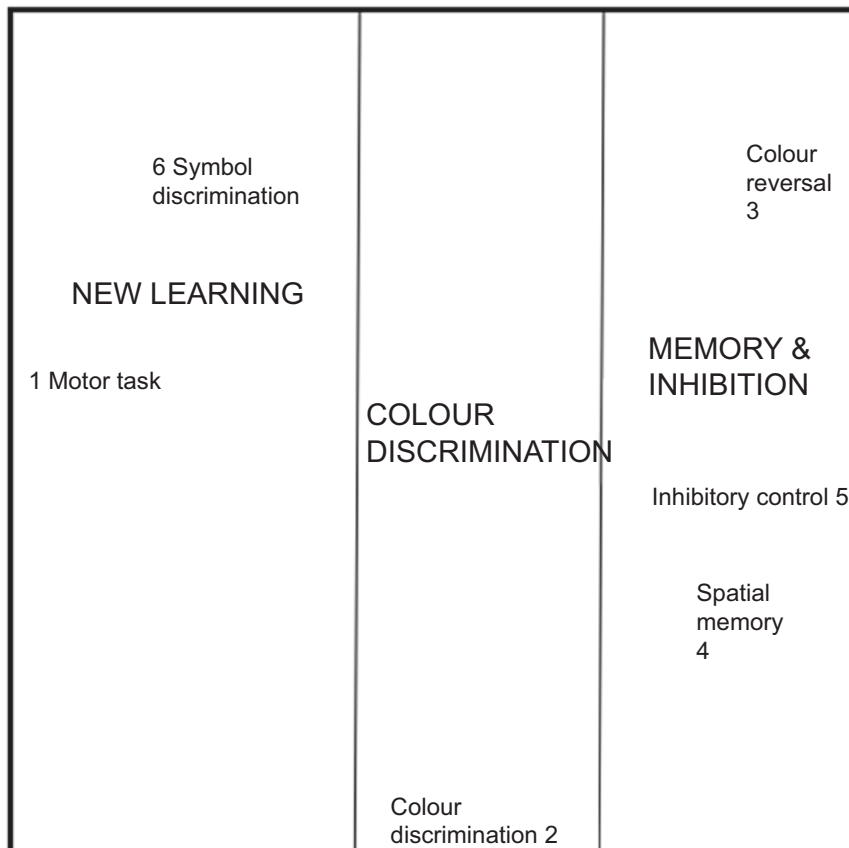
In their research, Hackett et al. (2019) used the multi-dimensional scaling (MDS) procedures of smallestspace analysis (SSA) (Bloombaum 1970) and partial order analysis (POSAC) (Merschrod 1980; Sharon 1995).

## Smallestspace Analysis

Initially, correlations were calculated between all pairings of scores on all tasks. This procedure produced initially *weak monotonicity coefficients* which were found to be nearly all positive, (positive = 13, negative = 2) suggesting the six tasks were to some extent measuring single construct (i.e., avian intelligence). The motor task had the 2 low magnitude (-0.18 and -0.23) negative correlations with the colour reversal task and with inhibition, suggesting motor task is slightly different from the other five tasks. Conversely, the largest positive correlation was motor task with symbol discrimination suggesting motor task is a valid part of the battery of tasks.

Hackett et al. (2019) then ran an exploratory SSA and found a one facet solution to be a very accurately solution (coefficient of alienation = 0.09273) (Fig. 5.1).

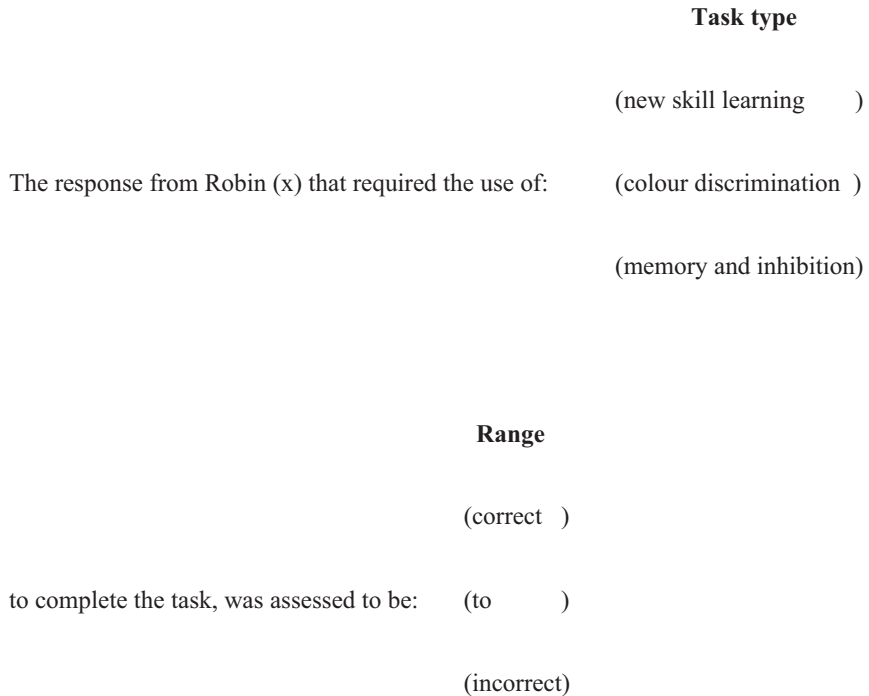
They named the facet task-type which had three elements in an axial arrangement. Based upon these results an initial mapping sentence was stated (Fig. 5.2).



**Fig. 5.1** Space diagram for one-facet smallestspace analysis for task-type facet

This initial mapping sentence interrelates the six assessment tasks and proffers a composite structure for a measure of avian cognition.

A two-facet solution was then calculated (coefficient of alienation = 0.00000). The first facet in this analysis (Fig. 5.3) had approximately the same axial structure as the axial facet in the one-facet solution. The second facet was of a modular structure with the elements of central/general and peripheral/particular (Fig. 5.4). Motor task was located at the centre of the plot because it is correlated with all other items and

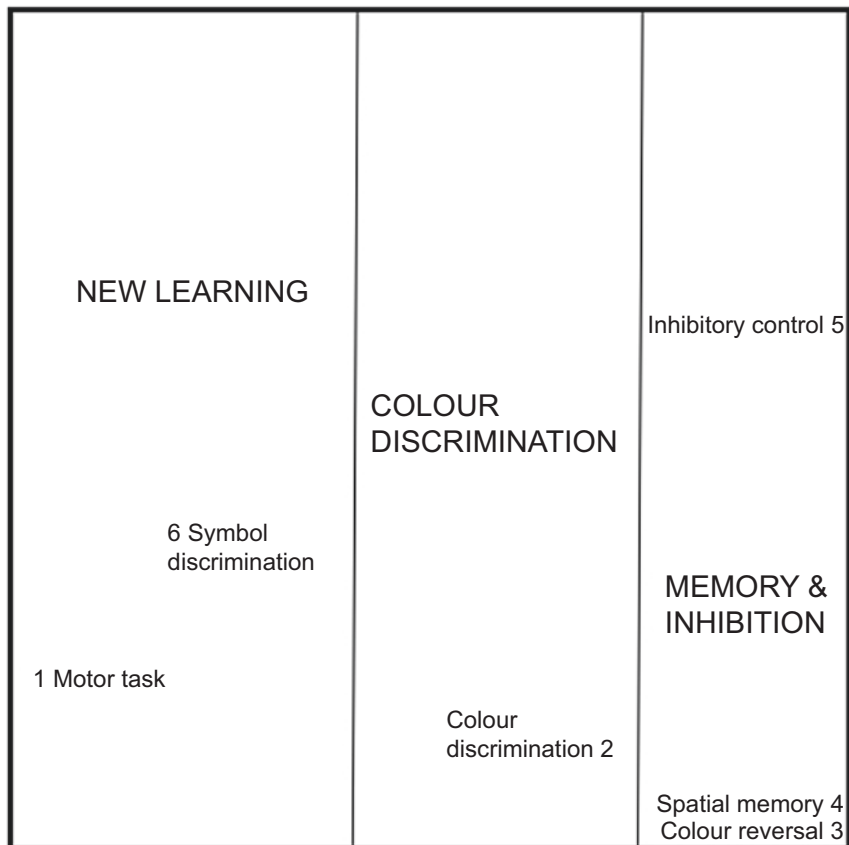


**Fig. 5.2** Initial mapping sentence for avian cognitive performance

demonstrated that motor task skills were at least somewhat associated with performance of the other tasks. It is interesting to note that performance of the motor task formed the basis performance on the other tasks and they were initially taught to perform the motor task.

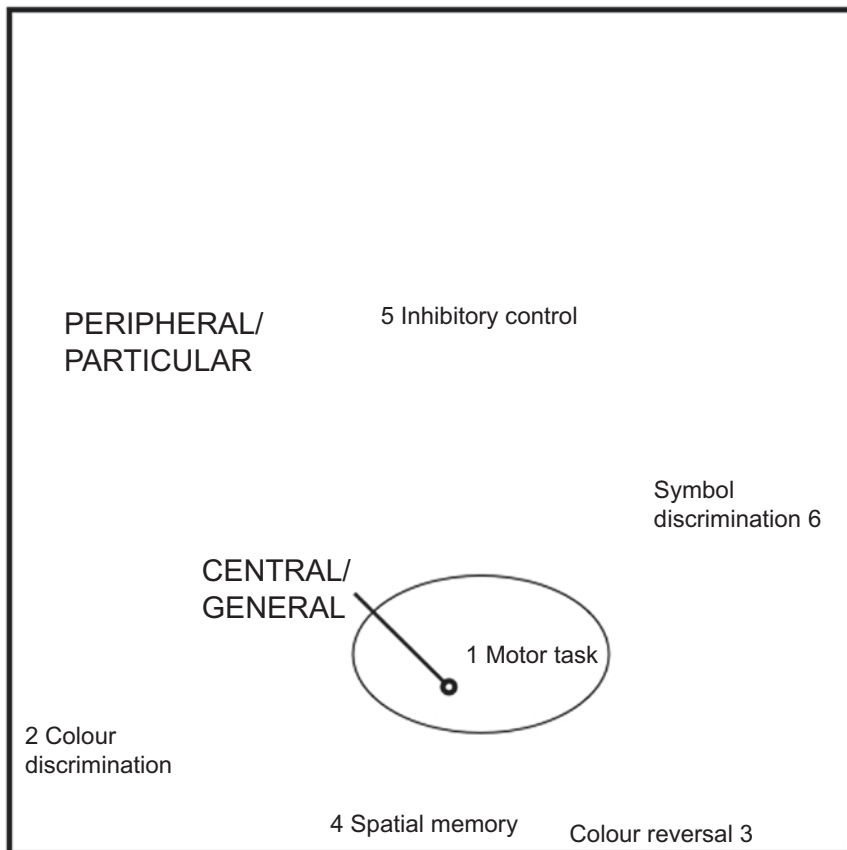
The two facets that were discovered were in separate plots and the evaluations and were relatively independent of each other. However, the tasks that were central and peripheral may at the same time be classified as requiring new skill learning, colour discrimination, or memory and inhibition skills. The two-facet solution led the authors to state the revised mapping sentence in Fig. 5.5 to illustrate the relationship of the two facets.

Having conducted smallestspace analysis of their data set, Hackett et al. (2019) then performed a partial order scalogram analysis of the data. Their analysis simultaneously analyses individual birds' performance



**Fig. 5.3** Space diagram for two-facet SSA: task-type facet

on the six tasks (Fig. 5.6). In the plot, individual birds are positioned upon two diagonal axes. Birds are located on the bottom left to top right axis in terms of their summated score (low to high) on all tasks. Bird 16 achieved the lowest summated profile score was positioned lowest on this axis and birds 1, 2, 3, and 4, achieved the highest summated scores were positioned top right. The other diagonal axis positioned birds close to each other if they had a similar score on a task. Lines are drawn in POSAC plots to capture similar scores and the shapes reveal the nature of the construct that is being partitioned. For example, in Fig. 5.6 it can be seen



**Fig. 5.4** Space diagram for two-facet SSA: focus facet

that the tasks of inhibition and colour reversal both partitioned the space into similar horizontal regions and were thus closely related to each other in terms of their effects on structuring robins' responses. Partitioning for motor task and symbol discrimination was in a direction that was similar to each other but in an opposite direction to inhibition and colour reversal, demonstrating that they play independent roles in task completion.

In Fig. 5.6 it is also apparent that the spatial memory task partitioned space into an L-shaped region. Furthermore, the colour discrimination task was partitioned into an 'inverted L' shaped region. The 'L' and



**Task type**

(new skill learning )

The response from Robin (x) that required the use of: (colour discrimination )

(memory and inhibition)

**Focus**

skills, that are: (peripheral/particular) to the completion of the task,

(central/general )

**Range**

(correct )

were assessed to be: (to )

(incorrect)

**Fig. 5.5** Mapping sentence for avian cognitive performance

‘inverted L’ shaped region demonstrate these tasks to play a moderating effect on the tasks that were partitioned horizontally and vertically with the different ‘L’ shapes moderating in an opposite direction. The way in which the tasks combine in the POSA is shown in Fig. 5.7.

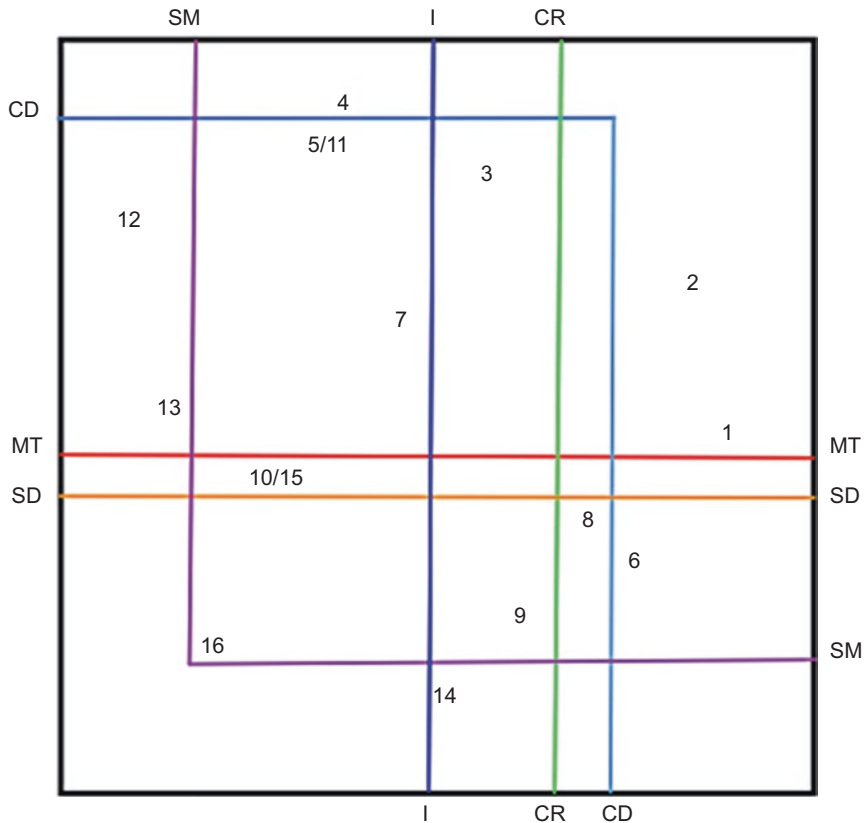
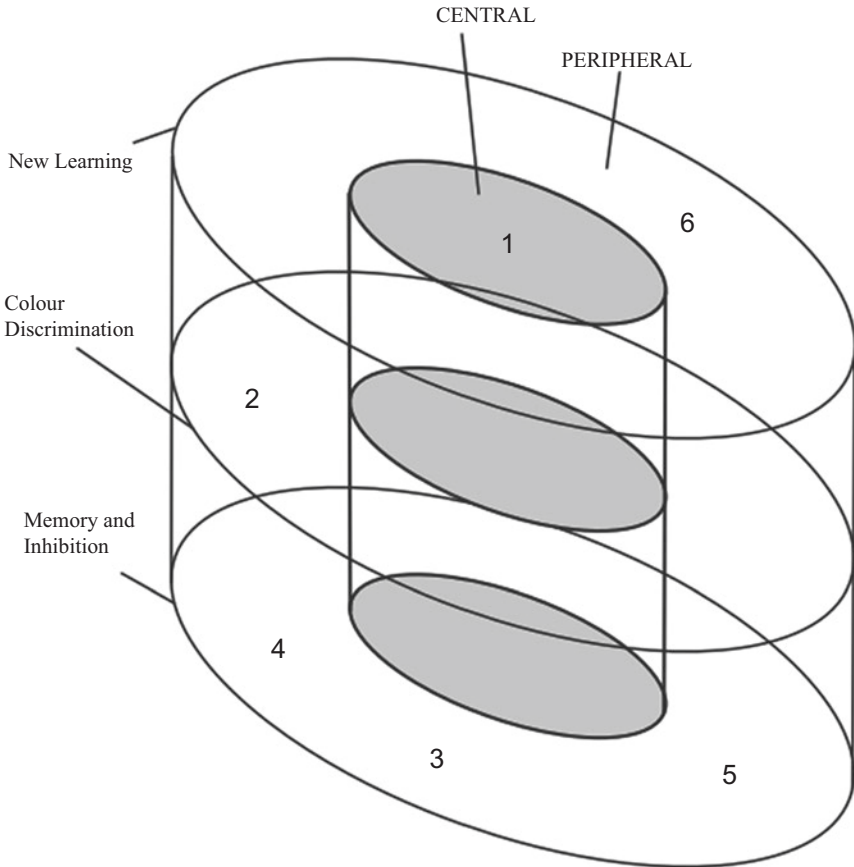


Fig. 5.6 Partitioning for POSA

In the one-facet solution the Hackett et al. (2019) claimed that the facet elements in their analyses represented how robins in their sample differentiate the tasks and the mapping sentences showed the similarities and differences between tasks/elements and their relationship to the test as a whole. They also noted how the elements echo how the battery was designed and was given to the sample of birds. In the two-facet solution, a modular facet was also discovered with a similar structure to the facet in the one-facet solution. A similar structure has often been found to in analyses of psychological processes, including human intelligence (Guttman 1965a, b; Guttman and Levy 1991) and demonstrates that



**Fig. 5.7** Two-facet partial order scalogram analysis

some items in an intelligence test battery are likely to be more associated and therefore more correlated, to other test or task items that are included in an assessment of intelligence. An argument can be made that these correlated items embodying a more general cognitive ability and in human analyses tasks that require inference that are found to be centrally positioned followed by tasks that require rule application with rule learning on the periphery.

In their two-facet solution, Hackett and colleagues claimed that their SSA revealed a structure for the processes that under-pinned the

differences in the tasks of the avian test battery. Shaw et al. (2016) claimed the presence of a general factor in their PCA that was analogous to the g factor of human intelligence. However, Shaw et al. (2016) discovered that there were large individual differences in the birds' performances. Hackett et al. (2019) found some support for a general form of intelligence but their initial exploratory analyses suggested tasks in the test battery were differentiable in terms of the type of test in conjunction with the required ability type of ability (new skill learning; colour discrimination; memory and inhibition) needed to complete a task.

Hackett et al. (2019) believed that their facet theory approach had the advantage of providing insight into the structure of avian cognition. They also emphasised the utility of the approach within animal cognition research which typically has a complex structure as well as small sample sizes and tests employing a small number of items. They also issued the caveat that the re-analysis was exploratory and performed on a set of data from non-facet theory designed research. Therefore, they said, further research is needed into avian cognition which is designed and analysed using facet theory. More specifically, they said that research is needed which included a greater number of test items which were designed based upon the sub-tests identified in SSA and POSA results. The need for more test items is exacerbated by the fact that the composition of the tasks that were included in the Shaw et al. (2016) only had single items in each task rather than, human sub-tests which are usually composed of many items. Hackett et al. (2019) also mentioned the potential of overfitting when the sample was of such a small size and not randomly selected but claimed that their resulting mapping sentence provided a template for future research which can be used to design enquiries to directly test the claimed structure.

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# 6

## Final Thoughts and Other Aspects of the Facet Theory Approach

**Abstract** Throughout the second edition of this book, I have presented examples of facet theory research. The illustrations I have provided have come from the research of many scholars and from my own. In this final chapter, I close the book by offering examples of one or two other ways in which facet theory has been adapted and used. These examples include its use as an approach that may be used in counselling or therapy, as a tool to plan research projects and as a sort technique.

**Keywords** Facet Theory • Mapping Sentence • Facet Sort • Facet Mapping Therapy • Research Planning

### Introduction

Thus far in this book, I have provided examples of many forms of facet theory research. The illustrations I have supplied have addressed many substantive areas of concern and have employed both quantitative and qualitative research approaches. I hope that I have demonstrated that facet theory remains a useful, although underused, approach to

conducting quantitative research in the social sciences: this is where it originated and where the majority of research is still executed. However, I have applied most of my efforts to demonstrating how facet theory has evolved into novel, qualitative areas of research and has made forays into scholarship from the humanities. As with the first edition of this book, the final chapter will concentrate upon more novel applications of a facet theory perspective including the none data gathering related approaches of facet mapping therapy (Hackett 2019) and the use of the mapping sentence to plan research projects. I will start however with the research data gathering approach of the facet sort technique.

## Facet Sort-Technique

My argument in favour of the utility of an approach to facet theory that gathers and analyses *qualitative data* in a *qualitative manner* is demonstrated in my above grid-painting research. The efficaciousness of this approach is built upon two characteristics of social research and facet theory: (1) quantitative analysis is sometimes, by its nature, an abstraction of essentially qualitative information; (2) there is an apparent utility to be found in real world applications of qualitative facet theory research. The division between qualitative and quantitative research is commonly made within psychological and social research: Often research dealing with numerical measures and non-number based research is seen as being at best only abstractly related. Many researchers have questioned the utility of this division and suggested a continuum of research perspectives (for instance, Moses and Knutsen 2007). Leaving aside questions about the veracity of the quantitative/quantitative research distinction, it seems reasonable to opine that facet theory has developed from a heavily quantitative tradition.<sup>1</sup> However, facet theory embodies forms of qualitative understanding. Sort techniques (Butt 2008; Coxon 1999) are to the fore of qualitative approaches to gathering personally meaningful information

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<sup>1</sup> Facet theory is related to some of the exploratory techniques used in personal construct psychology (see, Fransella and Bannister 2003; Kelly 1963, 1991) some techniques, such as the repertory grid, are analysed quantitatively.

about a content area. My recent research has included an approach I think of as a *facet sort* as an extension of sort procedures (multiple sort, triadic sort, rank sort, et cetera). David Canter has used sort techniques in a similar manner including in his research into consumer perception of confectionary. A facet sort is similar to the sort procedures just mentioned in that objects or the labels/names of objects are sorted in terms of their differences and similarities.

As mentioned in previous sections there are three archetypal single facet roles: axial, modular and polar, (shown in Figs. 3.3, 3.4, and 3.5). In a qualitative facet sort technique, respondents are presented with three pre-printed diagrams each of which represent the structure of one of the three single facet roles. The individual (or group) completing the procedure is then required to sort items (which are developed in reference to the mapping sentence for the project) in terms of the construct role (axial, modular, or polar). Respondents arrange items so as they are structured to form an axial facet arrangement. This facet stands alone from the effects of other facets and simply results in events or items that are being rank ordered into parallel strips using a user meaningful evaluation. Respondents then arrange items or events into a polar facet arrangement, which demonstrates qualitative differentiations and results in items being located in radial wedge-like areas. Respondents next arrange items using a modular facet arrangement by placing items or events in concentric circles with events that are increasingly more general characterised by this facets content being located progressively more centrally. This modular facet is often combined with the respondents polar arrangements wedge regions. Respondents' arrangements are photographed and their reasons for their choices discussed. Finally, through discussion with respondents it is determined whether structures of higher dimensionality 'make sense' to respondents within the context of their evaluations and if they do then more complex arrangements (such as the cylindrex, conex, cubex) are attempted.

I have used this technique with apparent success in revealing underlying structure (understanding) that respondents use in their evaluations without any form of quantitative evaluation of items or subsequent statistical analysis. Providing respondents with the three expected facet role structures appears to make it easier for respondents to meaningfully

sort than if they are given total freedom in sorting configurations. The advantage is that as these roles have been found to be present in many varied situations they are not unreal or artificial structures. Therefore, the researcher is not imposing an artificial structure upon respondents. Furthermore, initial use of this approach appears to demonstrate that if the respondent is presented by the researcher in person, a respondent's difficulties in attempting to fit items to a facet role when their 'natural' inclination is that the facet plays a differently structured role are apparent and the task can be exchanged for the more appropriate role. However, the approach awaits more extensive testing and usage.

To summarise, in the facet sort technique:

- the mapping sentence is used to design procedures and for sort materials and to interpret sort data
- respondents are required to sort information into archetypal facet roles: initially these are the three single role facets of axial, polar and modular
- later, archetypal role sort results may be employed as combined facet structures / combined roles (cylindrex, cubex, conex)
- facet sorts are spatial and non-numerical and solely employ visual categories
- simple and complex archetypal facets structures are *re-presented* to respondents and explored within the interviewer
- by referencing sort results to the mapping sentence used to design the procedure the investigator is required to state hypotheses prior to data collection and to support or refute these hypotheses on the basis of sort results
- sorts are recorded photographically with no numerical ratings

An extension of facet sort has been used in a therapeutic setting and this is presented below in the next section of this chapter.

## Facet Mapping Therapy: Using the Mapping Sentence and the Facet Structures to Explore Client Issues

Having used facet theory approaches to explore a respondent's personal understanding of a content area it appeared to me that this procedure could be modified to have a similar role within individual therapeutic settings. I therefore devised Facet Mapping Therapy (FMT) (Hackett 2019) as an application of the philosophy underlying facet theory to enable a counsellor or life coach to explore client issues. I have therefore used the mapping sentence, the facet roles mentioned in the preceding section and the one-, two-, and three-dimensional facet structures, of the radial facet, the simplex, the axial facet and especially the cylindrex and cubex, as tools to explore client issues. In practice, this entails the therapist freely exploring the issue area with the client in a manner that allows the client to express the thoughts, feelings, concerns, and so on that they have or goals they wish to attain. The areas that are identified in this open manner are then interrogated collaboratively with the therapist in order to identify sub-areas of the issue content. This may be a relatively quick process or it may also be part of a much longer-term therapeutic exploration. Having isolated relatively discrete and homogeneous issue sub-areas or facets the client is asked to elaborate the content of these facets into elements and to discuss how elements are related to each other.

At this stage of the client's encounter with the therapist, the roles of individual facets are identified and discussed in terms of the role a facet plays in structuring the client's qualitative or quantitative experiences of the life area under consideration.<sup>2</sup> Initially, client's assign or describe their experiences as playing a variety of roles in the life area under investigation. For example, issues that are predominantly one-dimensional may exist where facets may be identified as being axial facets, which depict experiences as forming parallel slices with the slices located at graphical extremes being least similar with a rank order between these extremes. Another one-dimensional issue may take the form of a modular facet life

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<sup>2</sup>The roles that facets may play are identical to those mentioned throughout this book.

area that identifies areas of life that are more or less central in reference to the issue in question. The polar facet may also be identified where this facet will reflect qualitative differences and similarities within issues. Throughout these procedures, extensive use is made of visual graphics of the facets and explorations of their roles in a similar manner as in the facet sort procedure.

As well as single dimension facets, two or more facets may be identified to combine and provide meaning in regard of a specific life area or issue for the client. For example, a two-dimensional facet model may be formed by the combination of a modular facet with a polar facet. In this instance a given issues may be seen to be more or less central to specific aspects of the clients life whilst simultaneously being understood as residing within a qualitative distinct aspects of their life (i.e., a radex). The radex structure is useful in therapeutic situation in order to expand, in a client meaningful way, an issue as it occupies a place in a client's life and is how relevant or important this issue is understood to be by the client. Explorations of the combined relationships of multiple facets are undertaken during later stages of the facet mapping therapy process. The single facets initially identified are expanded through consideration of the content area and clients are assisted in identifying the interrelationship between facets. The number of facets a client identifies as pertinent in determined by the issue the client is presenting. However, clients are encouraged to attempt to keep the number of facets to fewer than 4. The reason for this is two-fold: first, in situations where aspects of a person's life are interrogated clients find difficulty in relating more than three separate life areas in mind at the same time. Secondly, facet mapping employs a visual exploration of the client's world and most people have difficulty envisioning structures of greater than three dimensions.

In all instances when FMT is used with a client, the 'meaning' of a facet, the facet elements and the combination of facets, is client and issue specific as is the manner in which a client and professional will use the knowledge embodied in facet mapping to assist clients. It should also be noted that the words used to describe a facet role or combined facet roles, (e.g., radex, cylindrex, simplex) are probably not named by the practitioner rather the role of the facet is described, explored and understood in terms of the elements of the facet, their relationships and the combined facet

roles in respect to the therapeutic issue. Within this therapeutic context, the mapping sentence represents a client's understanding of their world in relation to the issues being addressed. The final facet in the mapping sentence, the facet of common range, is also identified interactively between client and therapist. This range will obviously be highly dependent upon the therapeutic context but I have found that the specific aims the individual has for their time with the professional form an extremely useful way of guiding the mapping sentence and the course of intervention. I have discovered by referring the client back to the range facet can be an extremely useful way to 'keep sessions on track' reminding the client why they are undertaking therapy. My personal experience has demonstrated this to have extreme utility in goal setting and pursuance in life coaching.

Explorations into client issues may commence as a verbal discussion but will progress at some stage to include a visual aid of some variety. I have personally used paper and pencil sketches to elaborate the facet and facet element structure that is elicited during discussions. I have also employed a specially constructed model of a cylindrex which had concentric circles and radial wedges incised into its surface and also a 'rubix cube' type geometric construction again with axial elements incised into its surface. By using these models, I was able to discuss with clients the location of an issue within their lives or life area (represented by the model) by identifying the location of the issue along the pertinent facets and other issues incorporated in the model. I must state at this stage that it is possible to use only paper and pencil, two-dimensional exercises with a client and to achieve what I describe in reference to three-dimensional modelling. The historical positioning of issues may also be identified along with their desired future positions. This facilitates concrete goal setting and attainment. Employing the pre-constructed three-dimensional model significantly aided in discussing and exploring client issues but the two-dimensional exercise in which the client and professional together worked to produce a sketch of the client world within the facet framework also has distinct advantages in that this is easier to use and does not confuse clients and therapists when multiple facets are used to simultaneously account for client experience and behaviour. The use of FMT is at an initial stage of development and much empirical work must

be undertaken before statements of its utility may be made with confidence.

In the final section of this chapter, I will conclude my thoughts about facet theory and mapping sentences by moving further away from traditional conceptions and uses of the mapping sentences without facet theory in order to coordinate mixed-methods research and to guide an overall research programme.

## Research Programme Coordination

Over the last three decades I have been involved in a very large number of research projects, ranging from those carried out by undergraduate students through research funded by major research grants. Within all these projects, research activities must be planned and the separate strands of research activity need to be coordinated. Two areas of research activity that I have found to particularly require intentional planning are those of bringing together qualitative and quantitative research in mixed method inquiries and the designing of projects that involve the coordination of multiple distinct data gathering and analysis methods such as any combination of interviews, sort procedures, focus groups, surveys, experiments, visual approaches, secondary and archival research.

When conducting research the use of flow charts (Gantt charts) and other project management tools greatly aid in project success. However, the Gantt chart makes no distinction between different types of research approach beyond time scheduling and resource allocation. It is obvious that considerably different materials and resources are needed in a large internet survey compared with in-depth interviews, or a focus group compared with the use of visual archives. It has been my experience that treating different research approaches as being inherently distinct, in their planning and design through to data analysis stages, assists in clear conceptualization of each of the research approaches and their successful completion. However, the overall aims of the project must be kept in mind in order to allow the separate research components to be brought together to successfully meet project objectives. In this situation, an overall mapping sentence for the entire research project aids in reaching



consilience (Wilson 1998) within a research programme. I have achieved comparability of different research procedures within a single project by placing these into an overall mapping sentence and using this as a complete research guide. An example of this has been my collaboration with a scientist from MIT<sup>3</sup> working in the area of climate change education. In this project we defined an, *overall mapping sentence for the design, implementation and monitoring of a program by geoscientists to raise environmental awareness* (Hackett et al. 2011). Facet A in this sentence defined the issue of concern as being contemporary climate questions, historical climate change, learning from past changes, and ameliorating climate change. Facet A clearly identified *issues* that our educational programme was to address. The next facet B presented the *educational materials* we had at our disposal as information about the climate system, historical temperature and greenhouse gas trends, and paleorecords. Thus far, we had specified the educational issue we were to address with an intervention and the educational materials we could choose from. Next, in facet C, the *scientists' objectives*, we specified the reasons *we* were undertaking the outreach programme as, for raising initial awareness, for increasing existing awareness, and for behaviour change. Then we indicated in facet D who would be fulfilling the role of *communicator* as being a psychologist, educator, and scientist. The perhaps longer term *behavioural objectives* of a given outreach activity were next stated in facet E as being reducing resource consumption, reducing emissions, and behaviour pledges. With more managerial a consideration, we included a facet (F) of *agent* that delimited the resources for the instigation and maintenance of a project was either the individual professional or the institution. Finally, we incorporated a range facet to focus our assessment of the overall outreach programme. As we were evaluating the effectiveness of the outreach programme, the appropriate range in this instance was specified as the confidence felt that the programme would make a positive impact in terms of the content of facet E. By explicitly setting out the project aims in an overall mapping sentence the research team was able to monitor, focus and coordinate our varied outreach activities.

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<sup>3</sup>Julio Sempulveda, PhD.

## Conclusions: Future Directions

In this monograph, I have presented a philosophical and theoretical evolution in the use of the facet theory approach along with novel applications of the facet theory and the mapping sentence. Advances have taken the form of extensions in the employment of multidimensional research design and analysis and the consideration of facet theory as a qualitative orientation in research, as a research project-planning tool and within a therapeutic domain. Throughout this book, I have demonstrated how the mapping sentence is central to facet theory and to my proposed developments. Indeed, I claim that it is the mapping sentence that is the single most unique feature of facet theory research and to my proposed extensions, especially within a qualitative context and as a stand-alone technique. The mapping sentence is a powerful technique, as it possesses the ability to integrate many forms of research, to provide a guide for therapeutic interventions and as management tool. I have shown that facet theory and the mapping sentence offer a potentially constructive philosophical basis for both the understanding of daily existence and enquiries into personal ontologies and mereologies.<sup>4</sup>

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# Appendices

## Appendix A: How to Construct a Mapping Sentence—Mapping Sentence Pocket Guide

Katie Lustig and Paul M. W. Hackett

### Introduction

The purpose of this pocket-guide<sup>1</sup> is to act as a stand-alone statement of how to construct both a declarative and a traditional mapping sentence.

Both types of mapping sentences we discuss are templates for designing, conducting, and the interpretation of research projects that come out of the social sciences and humanities.

Originally, mapping sentences grew out of the facet theory approach to research, developed by Louis Guttman in the middle of the twentieth century (he developed the traditional mapping sentence), Facet theory has been used in the above mentioned areas of academic and applied research. The mapping sentence as a research tool was further expanded on more recently by other scholars, mainly Paul Hackett, who created the declarative type of mapping sentence used for qualitative research studies.

In this short reference, we aim to get straight down to the point on how to create a mapping sentence yourself. We present the bare-bones

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<sup>1</sup>The seven stages arose out of earlier versions of a guide to assembling a mapping sentence that appeared in Hackett (2020).

of the construction process along with a brief explanation of the seven stages you need to go through to produce a mapping sentence. This guide is not is not meant to be about learning the elaborate details of developing and using a mapping sentence, nor does it delve into the complexities of facet theory or the philosophical underpinnings of these tools.

Instead, this pocket-guide is a useful reminder of the process of developing a mapping sentence. Our vision is that it will be used by researchers—whether they are academic scholars, students, or researchers working outside of academia, to follow along the process of conducting a research project at all stages of their study.

If this is your first time encountering mapping sentences, then you may wish to reference the books by Canter (1985), Hackett (2014, 2020), and Hackett and Fisher (2019) where this approach is further expanded on.

When you are using mapping sentences, you need to adopt a specific frame of mind: This is not a very difficult task. However, it does call for you to think of the world as a complicated place. Deeply invested in their research, mapping sentence users are not looking for simple associations between pairs of experimental and outcome variables, nor do they typically think of the world as being a series of stimulus and response events.

Instead, mapping sentence researchers perceive reality as being a complex maze of happenings, things, and phenomena that have intricate interactions. Based on this understanding, stimuli may be responses and responses may be stimuli. All of these are not discrete events and all are encompassed within the detailed inner-workings of an environment, temporal, social and spatial setting.

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## Stages of Developing a Mapping Sentence

For convenience and ease of use, this book breaks down the process of developing a mapping sentence into seven steps or stages. The stages are a guide and you may find that as you develop a mapping sentence you jump around a little between the stages.

The seven stages of constructing a mapping sentence are laid out on one page, followed on the page right next to it by additional details about achieving this particular stage.

### **Here are the 7 stages:**

1. Review the content of your research domain
2. Identify the main areas of meaning, or specific categories within your domain of interest (these are called facets)
3. Identify coherent sub-areas of the main areas you selected (these are called elements or elements of facets)
4. Think about how the facets and elements are related to you domain and how they relate to each other
5. Make a sentence by writing down the facets and elements in a way that represents how these occur in the real-world and connect these with ordinary language
6. Decide whether your research is purely descriptive or if you are exploring and discussing the effects of the facets and their elements on an outcome variable

7. If you are investigating the effects on an outcome variable, then select this specific variable and state the measurements you will take (this is called the range facet). If you are not investigating outcome effects but rather describing the domain for qualitative exploration, then you are already finished.

The two types of mapping sentence are called:

- declarative mapping sentence—this is used in qualitative research and provides a framework for interpreting the broad types of narrative and observational information gathered.
- traditional mapping sentence—this is used in quantitative research and provides a framework for interpreting the numerical data collected, which statistically investigates the relationships between the facets in terms of the variable stated in the range facet.

Before we go on to consider the 7 stages of constructing a mapping sentence we provide three examples of mapping sentences which include both declarative and traditional forms of the mapping sentence. The mapping sentences are included at this point to show you what a mapping sentence actually looks like and we will refer back to these examples throughout the book.

Music listener (X), prefers music from the:

**Genre -A**

1. vocal
2. instrumental

genre, that originated from the:

**Age/Era - B**

1. 18th century (1701- 1800)
2. 19th century (1801- 1900)
3. 20th century (1901-2000)
4. 21st century (2001-present)

era, which they access in the media form of:

**Access media** (how the music is accessed) - C

**Fig. A1** For declarative mapping sentence for musical preference



1. Streaming service
2. Digital download
3. CD
4. Vinyl
5. Tape

**Fig. A1** (continued)

The extent to which a person (X) believes that:

**A-Mode**

1. Military
2. Non-military

action directed towards:

**B-Target**

1. Terrorists
2. Countries supporting terrorists

serves the purpose of:

**C-Message**

1. Deterrence
2. Revenge

**Fig. A2** Traditional mapping sentence on personal beliefs and views on military response to terrorism (Gray and Wilson 2006)

3. Punishment

4. Elimination

5. Non-tolerance

**D-Range**

A great deal

to

Not at all

**Fig. A2** (continued)

Person X is interested in understanding space in terms of studying by evaluating:

**Lighting**

too bright

to

too dark

for optimal sight, and feeling:

**Temperature**

too hot

to

too cold

era, which they access in the media form of:

**Fig. A3** Declarative mapping sentence for evaluating space for optimal productivity

**Organisation (Cleanliness)**

too organised

to

too messy

in terms of this yielding an ideal space conducive for an optimal productive study session

**Fig. A3** (continued)

STAGE 1: REVIEW THE CONTENT OF YOUR RESEARCH DOMAIN DEFINITION:

**RESEARCH DOMAIN**

Research domain is also called the content area or domain, research area, and domain of interest. It is essentially the specific area to which your research findings will apply. It is not the questions you will ask in your research and neither is it the broad area that defines your research.

**For example:**

**Research domain:**

The specific game of cricket you are investigating

**Research question:**

Are fast bowlers more effective?

**Broad area:**

Cricket

STAGE 1:

The task of undertaking a review of the content or domain of interest can take several forms. Again, the domain of interest, also known as the domain concept (or domain content) is the area which you plan on investigating.

For example, a review may involve conducting a literature review (gathering resources like journal articles, books, conference papers, etc.,) which means going systematically through library databases, such as EBSCO to see what has already been published on your main concept of choice. Selecting the right keywords is crucial and you should keep a record of what you have searched for and where.

Another way to assess your area of interest is to discuss this main concept with colleagues and or others who are informed about the area of interest—these can even be friends or family members!

If you have one or two key texts, for example a book on the subject you intend to study, then looking at the list of references in this document is a good approach to widening the scope of your search. Also, trying to find authors who have mentioned the text you feel is important is another good way forward.

This initial stage may also call for you to conduct exploratory research into the subject matter of choice. This may take the form of informal or formal interviews, and so on. Simply chatting with people can help you brainstorm aspects of your research that you had not thought about.

It's important to make an effort to keep an open mind at this stage and let the information talk to you, rather than attempting to prove or uphold your beliefs about the research content.

Whatever procedures you adopt, by the end of stage one you should be extremely familiar, if not overly familiar, with the content of your area of interest.

**STAGE 2: IDENTIFY AND NAME THE MAIN MEANINGFUL SUBDIVISIONS OF THE CONTENT AREA YOU ARE INTERESTED IN (FACETS)**

**DEFINITION:**

## **FACETS**

Facets are simply the main categories (parts) of the content you are interested in: your research domain. Your facets must thoroughly describe your domain. When identifying facets, you must try to ensure one facet does not directly affect another facet while all facets must maintain a meaningful relationship with the 'whole' or domain of interest.

For example:

**Research domain:** what a person considers when creating an ideal space for productive studying

**Facets:** lighting, temperature, and organization

STAGE 2:

After conducting a literature review, as well as gathering other essential information concerning your domain interests (during stage one), you have now become very familiar with this content or subject area. In stage two, you use this awareness to help identify crucial features of your content domain.

Key features are meaningful subdivisions of the area, or phenomena that you plan to investigate.

For example, if you were interested in a particular group of students, the key sub areas of interest (categories that you think may be important in your understanding of this group of students) may be their age, gender and other demographic variables. However, it is more likely for more focused meaningful variables to be related to your particular interests. For example, if you were looking at how well adjusted students were during their first year at college, important sub areas may be the number and types of friends they have at college, how involved they were with extracurricular activities at the college, whether they came from the city where the college was located or elsewhere, their academic performance, and so on.

These key aspects may take the form of variables that may have been explored in past research that has addressed your domain concept, and which have proved to be important.

The variables or aspects may take other forms. For instance, they may be themes that have emerged from content analyses or recurrent thematic comments in interviews.

Once you have identified these key aspects for the research content, think of an appropriate name for each of the discrete themes you have identified. For example, you may have found that being involved with people from the college outside of class activities, knowing people who live in the city where the college is (but who are not part of the college), having a family member in the college, and so on, are all **social** features of students' lives.

The subdivisions of your content area are called **facets**. In stage three, we explain how to make sure the categories and related subdivisions (elements) selected are truly facets that maintain independence of each other, while still maintaining a relationship with the whole (domain concept).

STAGE 3: IDENTIFY MUTUALLY EXCLUSIVE SUB-AREAS OF ALL FACETS (ELEMENTS)

DEFINITION:

## ELEMENTS

Elements are the subdivisions of facets, or these can be thought of as the categories you chose that make up the ‘whole’ which is your area of research. They must also be independent of each other (one cannot directly affect the other), but must maintain a logical relationship with the facet, or category identified. All facets have at least one element.

**For example:**

**Research area:** Musical preference

**Facets:** Era, genre, and medium

**Elements:** Era

Eighteenth century

Nineteenth century

Twentieth century

Twenty-first century

### Genre

Vocal

Instrumental

### Medium

Streaming service

Digital download

CD

Vinyl

Tape



**STAGE 3:**

In this third stage you will have to think a little bit more about the categories, or facets you chose in the previous stage.

More specifically, you must consider the content of each of the facets and then identify and name the sub-components, parts, variables, themes, or sub-aspects of each facet. These subdivisions of facets are called elements.

The process is very similar to what you did at stage two and in fact, you may have already identified some of the elements when you were at stage two.

You need to figure out what elements are part of each facet. An example of this would be if you're looking at aspects of a person's preference for listening to music. After talking to some people about their preferences, or after conducting a literature search, you may select the main categories, or facets such as genre, era, and media.

We first acknowledge these as facets because they maintain mutual exclusivity, meaning one facet does not directly influence the outcome of another facet—like how the genre of the music does not necessarily determine the age or era it is from, and vice versa, and the media through which the music is listened to does not determine the genre. There will of course be associations between the facets and that is what the research is about!

Now that we know these facets are mutually exclusive, we may select the elements or subdivisions. For example, if you were looking for sub aspects of the facet of era, we may break this up into smaller categories (elements) such as Eighteenth century (1701–1800); Nineteenth century (1801–1900); Twentieth century (1901–2000); Twenty-first century (2001–present). Each of these elements makes up the facet (era) that is a main category of the whole (domain concept). The elements are mutually exclusive as a piece of music cannot be from the Seventeenth and twentieth century.

**STAGE 4: THINK ABOUT HOW THE FACETS YOU HAVE IDENTIFIED ARE LOGICALLY ARRANGED WITHIN THE CONTENT DOMAIN**

**DEFINITION:**

## CONNECTIVE PHRASES

Connective words and phrases, also known as ‘functors’ are the words or phrases that join each of the facets to each other in a logical manner. Ultimately, they help you put these pieces together to make sense, and form a sentence that not only relates to your research domain, but also reflects how these categories (facets) and subcategories (elements) embody a real world situation.

**For example:**

**Research domain:** Aspects of space influencing the ideal space for studying

**Facets:** lighting, temperature, and organization

**Connective phrases:** the words and phrases that are between the facets  
For example, Person X experiences space **in terms of the lighting and temperature as well as how it is organised to yield** an ideal space conducive for optimal productivity

The emboldened words are the connective words and phrases between the facets that give a precise meaning to the sentence. Changing these changes the meaning of the sentence and thus your research.

For example, if you change the emboldened word **and** to **or**, the sentence has a different meaning whilst the facets and elements have not been changed.

STAGE 4:

Next, we must make logical connections between each of the facets, and elements, in relation to each other and to the research domain as a whole.

When we say that you need to think about the logical order of facets within your content domain, we mean you must think about how these facets, and their respective elements, occur in the real world. Then, arrange these in an order that reflects the form they take in reality. Sometimes, the order may be obvious and other times it may be trickier to establish. Changing the arrangement of facets, sometimes, will make a great difference to the depth and meaning of the mapping sentence.

For example, if you wanted to investigate sport performance and you had two facets, sport type and speed of performance, you have to ask yourself if the type of sport should be written before (or after) the speed at which they perform the activity: which makes more sense. Does it

make more sense to say, the person “played *football* **quickly**” or the person “**quickly** played *football*”? In this somewhat silly example, you may recognise that the arrangement of facets makes a difference in the meaning of the sentence; in the latter example the meaning is probably not what you were intending, and the meaning is not as clear as it is in the first example.

So when you are thinking about the placement of words and facets, it’s important to keep in mind that word order plays an integral role in developing the meaning of your mapping sentence, and thus, the research design, and how you carry this out. Since the design and conduct of a study all depend upon the structure of the mapping sentence itself (to work as a framework to accomplish this investigation), you need to play around with the arrangement of facets and elements, specifically how you word them, to direct your project in the most appropriate manner towards the questions of a research domain that interests you and which you intend to explore, understand, and interpret.

STAGE 5: WRITE THE FACETS IN THE ORDER YOU DECIDE REPRESENTS HOW THESE OCCUR IN THE REAL WORLD AND USE WORDS AND PHRASES TO CONNECT THE FACETS TO CONVEY THEIR MEANING AS YOU INTEND

DEFINITION:

## MAPPING SENTENCE

The mapping sentence is generally a simple sentence written in ordinary language that provides a framework for designing and conducting a research project. Basically, it is a layout, or a ‘map’ that identifies parts, and subdivisions of your domain of interest and describes how these parts work with each other in reality. This gives a structure to investigate a concept of choice to extract rich, meaningful insights about something occurring naturally in the world.

STAGE 5:

The overall aim when designing a mapping sentence is to form a sentence which incorporates all of the facets you have in your research in a way that reflects the research domain in the real world.

Stage 5 can be thought of as the end part of stage 4. After considering the ordering of the facets in stage 4, you have to jot them down in the

most sensible fashion by writing words and phrases between the facets to reflect the way the facets connect in reality (these connections have been described already): You actually connect one element from each facet rather than the facets themselves.

When you have completed writing your mapping sentence, you can read through the mapping sentence multiple times slightly changing how you read it each time. Each time you read through the sentence you select a different element from each facet and insert this between the connecting words and phrases. Questions or other research tools are then developed that represent each reading of the mapping sentence and by adopting this approach you are sure to cover the whole of the research domain.

In the example mapping sentence for preferences in listening to music, the facets we chose were the genre of the music, and the age or era when the music originated and the media through which the music was accessed. We arranged these facets as follows: first genre which we put first because it was a very general category so it made sense that this would be the first thing to acknowledge to set the stage for the rest of the mapping sentence. So we start our sentence,

*“Music listener (X), prefers music from the:*

*Genre*

*Vocal*

*instrumental*

*genre”*

Here the emboldened word “genre” is the name of a facet. Remember, it is the elements that are actually connected in the sentence and not the name of the facet. Below the genre content facet (in Fig. A1), we provide the elements of vocal and instrumental. When we are using the sentence to understand our research domain instead of the word genre we would incorporate one of the elements of the genre facet where the word age appears. Therefore, one example of this would result in:

*“Music listener (X), prefers music from the **instrumental genre**”*

We then join the genre facet logically to the next facet (age/era) with a phrase that embodies the genre facet’s relationship with the era facet. The phrase we chose was:

*“that originated from the:”*

We chose the age or era from which the music originated as the second facet since it identifies preference of choice in music, as we believed this to be important. As stated in the example in stage 3, we note that the era facet and its elements are:

*“Age/Era (what era the music originated from)  
 18th century (1701–1800)  
 19th century (1801–1900)  
 20th century (1901–2000)  
 21st century (2001–present)  
 era,”*

We then connect this to our final facet (access media) with the phrase, *“which they access in the media form of:”*

From our earlier discussions with people who listened to music, we saw that they often mentioned that an important factor in their music listening preferences was the media they accessed the music through. Therefore, this facet was included in the following format:

*Access media (how the music is accessed)  
 Streaming service  
 Digital download  
 CD  
 Vinyl  
 tape*

The elements under this third facet (access media) are streaming service, digital download, CD, vinyl, and tape.

The connective phrases (or functors) we chose join the facets together in a way that depicts the real world situation of preferences in music.

STAGE 6: DECIDE WHETHER YOU ARE: (A) DESCRIBING A CONTENT AREA OR (B) DESCRIBING A CONTENT AREA IN A WAY THAT AFFECTS AN OUTCOME VARIABLE THAT YOU ARE MEASURING

DEFINITION:

RANGE

The range facet is a description of a measurement variable in terms of the numerical data to be collected and analysed within a traditional mapping sentence, which is only required when taking a quantitative approach to research.

For example:

Research domain: Facebook fights

Range facet: Frequency of posting and commenting

STAGE 6:

In the sixth stage, if you decide that you are describing a research content in order to provide a framework to analyse qualitative data, then you are designing a declarative mapping sentence. However, if your research is quantitative then you are developing a traditional mapping sentence, which calls for and holds a place for a measurement (range facet). To learn more about the role and differences between the two types of mapping sentences, reference chapter 3 of the unpublished *Mapping Sentence User's Guide* (Hackett and Lustig 2020).

If you are creating a structure, or layout for a qualitative study using the declarative mapping sentence, then you look at the categories (or facets) you chose to make sure they comprise concrete individual elements, instead of ranges. Going back to the example of influential aspects in musical preference, each of our facets (genre, era, and medium) can all be subdivided into smaller chunks related to that category. As previously stated in stage 3, the elements under genre, in a declarative sense, would be instrumental and vocal. These are both individual subcategories that make up the facet of genre. The term genre does not call for any measurement; rather it represents an aspect of choice towards a specific musical preference that differs from person to person.

In fact, if we tried to make the facet of genre into a measurement range, it wouldn't make sense. Trying to say, a person may consider choosing a genre from instrumental to vocal would be illogical, since musical preferences are associated with some expression of preference towards individual parts within the facet of genre, and genre itself cannot be expressed as an outcome range.

If you are working on designing and conducting a traditional mapping sentence for a quantitative investigation, you must create a space in your mapping sentence for a range facet, since we need to record

measurements. For example, if we are looking at Facebook fights and attempting to understand why and how they occur in reality, we may want to know how frequently a person posts and comments on a regular basis, as this is key to understanding how involved a person is in their participation in social media. This frequency can be recorded as a range, giving us a measurement to be allotted and coded for observation of the behaviour of a specific person. We call this a range facet, since it describes a measurement and not a concrete, isolated subdivision of a content category.

Again, you must keep in mind the content of the particular type of mapping sentences (traditional and declarative), facets and elements, which are dependent upon the approach of your study (qualitative or quantitative). If you don't acknowledge this step along the way, your mapping sentence may be illogical, leading you in a direction that won't produce very reliable, valid, or meaningful outcomes.

STAGE 7: IF YOU DECIDE B IN STAGE 6, THEN YOU WILL BE TAKING A MEASUREMENT AND IDENTIFYING THE VALUES. WRITE THESE AT THE END OF THE SENTENCE AS A RANGE FACET. IF YOU DECIDE YOU ARE SIMPLY DESCRIBING A CONTENT AREA THEN DO NOT INCLUDE A RANGE FACET

#### STAGE 7:

To reiterate, in stage 6, if you decided that you were designing a declarative mapping sentence for use with qualitative data, then your job is complete. However, if you chose to develop a traditional mapping sentence, you will now have to state the nature of the quantitative measurements you intend to make. The values of these measurements are then stated as a measurement scale at the end of the mapping sentence in the response range.

For example, a traditional mapping sentence that has been designed to develop a questionnaire for assessing attitudes towards American retaliation after the terror attacks on their country in 2001 would require a range facet (see Fig. A2). This example was originally developed by Gray and Wilson (2006), who designed a questionnaire from the mapping sentence that was made up of three content facets and a range facet. The content facets were mode, target, and message that all connected to the range facet that consisted of values between "a great deal" to "none at all."

The content facets were as follows: mode of action taken against terrorism ([1] Military and [2] Non-military), directed towards the target ([1] Terrorist and [2] Countries supporting terrorists), and with the purpose of the message being ([1] Deterrence, [2] Revenge, [3] Punishment, [4] Elimination, and [5] non-tolerance).

When developing a questionnaire from the mapping sentence you form combinations of all of these content facets in relation to the range facet. This allowed the authors to develop a questionnaire on a person's beliefs concerning retaliation to terrorism that addressed the retaliatory: action, particular target, and message.

## Conclusions

In either of their forms, mapping sentences are basically simple investigative tools that provide a framework to design and conduct research. They have been used in applied and theoretical research in a wide variety of situations.

Mapping sentences have the ability to keep a researcher 'on track' in their process, as well as to provide a structure within which the events under investigation are clearly defined.

Mapping sentences are research methods from the social science and offer a way in which a social science study is undertaken (i.e., the methods used in the design and execution of a project). Mapping sentences are extremely important in determining the quality of the information the research produces. As philosopher Nancy Cartwright (2014) says, it is essential to clearly specify the meaning of the concepts that are being investigated in a research project. She goes on to say that there is a need to determine whether or not a concept applies to the domain interest you are investigating. We believe that the mapping sentence fulfils both of these requirements.

Cartwright (2014) takes this point further by stating, "the two endeavours of characterising or defining concepts, on the one hand, and devising methods for determining when they obtain, on the other, must go hand in hand." (Cartwright 2014, 309). Again, we argue that the mapping sentence meets these twin requirements by providing a definitional



framework for a research domain of interest and suggesting how data should be gathered and then analysed.

The traditional and declarative mapping sentences are similar yet different. They are used in distinct ways due to the different types of information that they gather, respectively, numerical and narratives. The mapping sentence crosses borders between quantitative and qualitative researchers to offer a truly mixed-method form of social science and humanities research. Ultimately, this tool has the potential to allow us to reason about our world from both qualitative and quantitative points of view. As Hacking (1992) notes, disciplines adopt their own sense of what is a reasonable approach to claim valid knowledge and what is not. Some disciplines may employ statistics to forward what are deemed logical arguments about a subject matter, whilst others see valid communications in a rich narrative. We would hope that through the continued use of the traditional and declarative types of the mapping sentences, a common group for statements of validity may be at hand.

In this brief book, we hope we have provided the reader with a simple, concise guide that shows you how to assemble a mapping sentence. We did not, at any stage of writing this pocket guide, wish to produce some massive authoritative work about mapping sentences. The purpose of this book is simply to give a step-by-step outline and a brief explanation on how to develop a mapping sentence, how to use this as a framework for designing and conducting a research project, and to hopefully extract more reliable, valid, and meaningful insights about your area of interest.

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# Glossary of Terms

In this research, there are a series of terms that have been incorporated into the research that have specific or nuanced meaning. Below is a list of the precise meaning of these words and phrases along with further details of the terms and appropriate references.<sup>12</sup>

**Affective Neuroscience** That aspect of neuroscientific studies that is concerned with emotions: Neuroscience viewing emotions.

**Axial role (facet)** An axial facet is a facet arrangement in which items or events are assessed or understood to possess more or less of a given construct and form a simple approximation of linearity. Items that are closer to each other are understood as more similar in terms of this construct whilst those further apart are more dissimilar.

**Cartesian Mapping** A coordinate system that is used to locate a point: on a two-dimensional plane, the point is located relative to a point of origin and two perpendicular axes; in a three-dimensional space, location is specified relative to a point of origin and three mutually perpendicular axes or planes.

**Category** A category is a class or some other form of partitioning or breaking up of things or people on the basis of these having some shared characteristic. In philosophy, “A system of categories is a complete list of highest kinds or genera.” (Thomasson, 2018), or, categories are considered as an exhaustive set of classes within which everything may be allocated.

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<sup>2</sup>The same or broadly similar glossary appeared in Hackett (2020).

**Clause** Traditionally, a clause is said to consist of a subject and predicate. It is a unit of grammatical organisation ordered directly below the sentence. It is the smallest unit in grammar that is able to express complete ideas. A clause may constitute a complete sentence in and of itself, or it may be part of a sentence. A main clause is a clause that is able to stand alone and forms a complete sentence as it has a subject and predicate. A subordinate clause is dependent upon a main clause and is part of this main clause, and is usually preceded by a conjunction.

**Cognition/Cognitive** Cognition and cognitive refer in some way to the mental action of thinking and knowing. The American Psychological Association (2018) defines cognition to include awareness and knowing including: “perceiving, conceiving, remembering, reasoning, judging, imagining, and problem solving”. Furthermore, the American Psychological Association states that traditionally, the components of the mind are cognition, affect, and conation.

**Cognitive neuroscience** Cognitive neuroscience encompasses both psychology and neuroscience and includes neuro-anatomy and neurological approaches along with cognitive and biological psychology. Cognitive neuroscience is concerned with the scientific study of the neurological features associated with cognition and the essential underlying substrates of overt and covert behaviour. Different neural imaging approaches are central to its methodology but also include methodologies from cognitive and experimental psychology, behavioural genetics, psychometrics along with neural network and computer-based modelling. Clinical research, of individuals with neural injury/trauma, and comparative animal studies, are also employed.

**Cognitive representations** The conscious thought based depiction, description, or account, often visual, of somebody or something. Such representations are often of situations rather than isolated stimuli.

**Concept** In philosophy, a concept is an important term in reason and language and is a mental representation or image, an idea that parallels an event or entity or class of events or entities or the indispensable aspects of the entity or event.

**Connective ontology** (see ontology (connective))

**Construct** An explanatory variable that cannot be observed directly is called a construct. An example is intelligence, which cannot be directly seen in operation but is inferred to explain ‘intellectual’ types of behaviour. Constructs have two extreme points or poles, for example, ‘hot-cold’, ‘fast-slow’. Events we encounter may be judged or measured using constructs, where we may assign an event to a point between the polar opposites. George Kelly used constructs as the basis of his personal construct psychology.

Within this book, I have used the term construct in a similar manner to the definition provided by the (American Psychological Association 2018). Thus, I take a construct to be an exploratory theoretical model that is based upon empirical research or as a hypothetical model arrived at through inference from empirical data.

**Cylindrex** A facet structure frequently present in facet analyses, which is formed from a combination of three facets: a non-ordered polar facet combined in the same plane as a wedge-like modular facet (a radex) along with an axial facet orthogonal to the other two facets. In the resulting cylindrex, items or events that are more generally related to the research domain are centrally located in the radex whilst the axial facet differentiates items by ordered region.

**Declarative Mapping Sentence (DMS)** A declarative mapping sentence is a form of a traditional mapping sentence (see Mapping Sentence (in a general sense) later in this glossary). It has been developed by Paul Hackett (Hackett 2014, 2016a, b, c, 2018) and is similar to its traditional counterpart except that it often does not include a range facet and is usually used in qualitative and philosophical research **Element (see facet element)**

**Epistemology** Epistemology is the study of knowledge, which is concerned such things as, Where does knowledge come from and what are its limits? What is the structure of knowledge? Epistemology is also interested in the principles used to support knowledge and the ways in which these principles are conceived in relation to knowledge. Epistemology is also concerned with how knowledge is created and promulgated within specific knowledge related disciplines, and with knowledge in particular areas of inquiry.

**Facet (a)** A facet can be thought of as a variable, construct, or some other form of discretely identifiable component of a definition of a domain of research or important factor influencing a content that is under investigation. The facets that are specified for a research study, when taken together, constitute all of the variables that are of interest in the study. Facets are specified that are as much as is possible mutually exclusive in terms of their combined influence within the research area.

**Facet element** A facet element (or often just element) is a sub-division of a facet that is mutually exclusive with other elements of a facet, as near as possible to being mutually exclusive. Facet elements are not the means by which a mapping sentence is assessed but they constitute the structure of the phenomenon under scrutiny. Elements should not be confused with a facet range (however, a range facet will also possess elements).

**Facet Structure(s)** Facets possess a limited number of acceptable multi-dimensional structures that are pictured or represented in two-dimensional space.

Single-facet structures may take the following forms.

- Linear—in this situation, events are similar or dissimilar to each other, so they may be positioned on a straight line and the similarities between event pairs are maintained (see, Gabriel 1954; Runkle and McGrath 1972) (this is called a *simplex*).

- Circular—in which a matrix of correlations between events are high along the diagonals and at each corner and the correlations at the centre of the matrix are at their lowest (see, Brown 1985) (this is called a *circumplex*).

Multiple-facet structures (also known as higher order structures) include come about when more than a single facet explains a content area and these facets interact. Examples of such multiple facet roles include:

- Two intersecting ordered facets (two simplex structures) form a *duplex* in which the two facets are positioned orthogonally to each other (see, Elizur and Shye 1976).
- A simplex intersecting with a circumplex for a *radex* (Lingoes and Borg 1977). Coxon (1982) states that this facet structure is depicted as a circumplex with multiple concentric circles that also has lines that originate at the centre of the circles and progress to the edge of the plot.

As well as two-facet structures there are multi-facet structures that are made up of three facets, for example:

- The *cylindrex* is composed of two or more *radex* stacked one above the other (Brown 1985). This structure comes about when a quantitative assessment (a simplex) combines with a qualitative evaluation (a circumplex) forming a *radex* and the *radex* is independently associated with, or present at, a series of different levels of another ordered facet (see, for example, Hackett 1995).
- The *triplex* is also a three-facet structure. However, this time the three facets that combine are all ordered facets (simplexes) (for example, see: Borg and Mohler 2011).

The above higher order structures (and other facet combinations that have not been presented) constitute complex spatial hypotheses that are the combinations to the more rudimentary hypotheses in the two-dimensional structures and are related to Guttman's work (Hildebrandt 1986).

**Facet Theory** Facet theory is a meta-theoretical approach to research design, implementation, and analysis (Canter 1985; Hackett 2014). Facet theory allows the mapping of some facet of an individual or group of people in reference to a process within a specified context. It achieves this through using a mapping sentence (facet theory's main research tool) the approach brings together a prescribed analysis of a research domain's contents with analytic approaches such as Smallestspace Analysis (SSA) and Partial Order Scalogram Analysis (POSA): These analyses are

multidimensional. Facet theory integrates the design of research content with data analysis, which allows for meaningful appraisal of a research domain and permits the possibility of theory development (see, Brown 2010).

**Louis Guttman** Louis Guttman (1916–1987) was an American mathematician, sociologist, and professor of social and psychological assessment. He is best known for his scholarship in the area of social statistics. He is best known for his psychometric work (especially multidimensional scaling and his philosophical work on multidimensional analysis approaches), the origination of the Guttman Scale and for the development of facet theory.

**Hermeneutics** Hermeneutics is a branch of knowledge that is concerned with the content of narratives or texts. Specifically, hermeneutics is concerned with the interpretation, of such texts and most commonly in the context of theological or literary texts.

**Hylomorphism** It comes a combination of the two Greek words for matter and shape. This is a term from metaphysical philosophical theory developed by Aristotle that all physical objects, their being, is composed of a combination of matter and form. Hylomorphism is a central doctrine of Aristotle's philosophy of nature and runs beneath much of his later thinking.

**Idiographic** An idiographic approach describes the characteristics of the individual, making individuals the unit of study. Generalisation is not the usual aim of such an outlook.

**Intelligence** There are different definitions of intelligence, but most involve notions of an individual's ability to develop and employ knowledge and skills.

**Learning** Learning is demonstrated is a relatively permanent change in behaviour that is brought about due to experience. Learning is a major component or type of avian cognition and is often assessed in research into the cognitive abilities of birds (for a contemporary example see, Lawrence and Noonan 2018). Sub-types of learning in birds include social learning (e.g., Riebel et al. 2012), song learning (Mennill et al. 2018; Rivera-Cáceres and Templeton 2017).

**Mapping** A mapping is a theoretical or empirical statement that is provided by a mapping sentence for a research domain, the specification of a content area in terms of its pertinent facet and facet elements.

**Mapping and Mapmaking** The process of making maps, otherwise known as cartography, is defined within this research as being active and purposeful. It is important to distinguish mapping and map-making from the mapping sentence. The mapping sentence is a theoretical tool from Facet Theory and has little to do with cartography, or geography. Within this writing, 'a mapping' is defined to be the theoretical statement of structural content within a mapping sentence and again has little to do with cartographic maps.



**Mapping Sentence (in a general sense)** A mapping sentence is a formal statement of the research project that is being conducted in the format of a natural language sentence (see, Hackett 2014, 2018). A mapping sentence has 3 types of facets (more on these later) each of which are linked to each other using connecting words to form a sentence with a structure that approximates normal prose. The sentence suggests the expected inter-relationship between the content facets within the context of the specified research inquiry. A mapping sentence is made up of three types or categories of information (these categories are called facets). The three types of facet are the background facet, the content facet, and the range facet. Background facets specify details of the events, people, or objects to be classified and/or investigated in the research project. Background facets may also be sub-divisions of the population under investigation that you believe to be important in understanding the content of the domain under enquiry. Content facets specify the research domain that will be investigated in the project. Content facets are the major sub-divisions of research content. For example: if your research project is investigating user experience of a certain place, the facets will be the major aspects of place experience that have been identified in prior research to be influential in effecting users when they are in that situation. The more complex the investigation, the more content facets a project will contain. The range facet<sup>2</sup> specifies the overall orientation of the research project and/or is the measurement that will be taken in the research (for example, in assessing user's experience of a place the range facet may well be one of degree of satisfaction with the various aspects of place as specified in the content facet overall customer satisfaction).

A mapping sentence is a theoretical statement of a research area that is a fundamental component of the facet theory approach to research. A mapping sentence is a group of statements that express an affectual, cognitive, or conative concept through a specific, empirically derived process. The statements are facets (see above) that are linked by using everyday connective language to suggest the relationship between the facets. The mapping sentence is a series of hypotheses about the research domain. Later in facet research, inquiry explores the validity of the sentence's statements and allows for the alteration of its structure through of the research process.

**Mapping Sentence Mereology** A mapping sentence is a sentence written in ordinary English prose which contains facets and elements and where the facets are the major components of a research domain and the elements are the exhaustive, mutually exclusive conditions of the facets. A mapping sentence mereology is a term used in qualitative or philosophical facet theory and with the declarative

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<sup>2</sup>In original research within facet theory, the range facet is always present and specified prior to data collection.

mapping sentence. Mapping sentence mereology refers to the inter-connections and inter-relationships between the facets and the facet elements in a mapping sentence (usually declarative) including the connective components and functors.

**Mapping Sentence Ontology** A mapping sentence is a sentence written in ordinary English prose which contains facets and elements and where the facets are the major components of a research domain and the elements are the exhaustive, mutually exclusive conditions of the facets. A mapping sentence mereology is a term used in qualitative or philosophical facet theory and with the declarative mapping sentence. Mapping sentence ontology refers to the relationships and properties between the concepts and categories a mapping sentence (usually declarative) including the connective components and functors.

**Mapping Sentence—Declarative** (see, declarative mapping sentence)

**Mapping Sentence—Traditional** (see, mapping sentence in a general sense)

**Mereology** Mereology is the theoretical study of the relationship between parts in relation to the wholes they constitute and also of part to part within a whole (Varzi 2016). It is a term typically found in philosophy and mathematical logic. The term mereology was originated by Leśniewski (1927–1931). Mereology has typically been used in reference to the parts of objects and metaphysics. However, mereology has also been employed in the investigation of social mereology (Hawley 2017; Petranovich, S. 2018; Strohmaier 2019). This has been somewhat controversial and the legitimacy of considering people as parts of a committee in the same way that a nucleus is part of an atom of an engine is part of a car has been questioned (for example by Ruben 1983).

The word Mereology comes from the Greek word for part. The study of mereology dates from Pre-Socratic times. Mereology is a form of study in which general principles are sought to explain the nature of the relationship between an entity and the parts that comprise that entity. Mereology is also concerned with the relations between the parts to the whole along with part-to-part relationships within a whole. Following philosophers such as Plato and Aristotle, many later philosophers wrote considerable amounts upon mereology including the ontologists such as those mentioned in this text (for example, Duns Scotus, Aquinas, Ockham, Leibniz). More recently, mereology has appeared in the work of writers such as Husserl, Brentano, and Leśniewski.

**Meta-Mereology** Meta-mereology has been used to mean “a thorough analysis of it” (mereology) (Pietruszczak 2018). However, within this book the term meta-mereology is used to mean a mereology of or about a mereology or mereology.

**Meta-Ontology** I am using the term meta-ontology in the sense of it being a meta-theory of ontology. Consequently, a meta-ontology is an ontology of an ontology or a dialogue on an ontology and its methodological components.

**Metaphysics** Within philosophy, metaphysics investigates areas such as substance, properties of things, emergence, change, cause, possibilities, time, nothingness, and personal identity. Sometimes metaphysics is interpreted literally as being *meta*, (beyond or transcending), physics. Metaphysics is the discipline that studies and attempts to explain the fundamental aspects of being and the world. As can be seen from the above it is often difficult to define in a simple manner exactly what metaphysics is.

**Modular role (facet)** A modular facet embodies understanding that structures a content area so as some items are located more centrally than other more peripheral items or events. Here, some events are seen to be more related to all other events in terms of a construct and these will be centrally positioned whilst some items are more individualistically understood in terms of the construct and will be more peripherally situated.

**New Zealand Robin** The New Zealand robin is a sexually dimorphic small dark grey-black passerine with a light coloured front. The New Zealand robin has been split into two different species. These are the North Island robin (*Petroica longipes*) and the South Island robin (*Petroica australis*). However, the research reported in this book is concerned with the North Island robin (*Petroica longipes*). Previously, the two-species were considered conspecific.

**Nomothetic** A nomothetic research outlook is concerned with the study of groups of individuals. Often attempts are made to select representative samples that allow result generalisation.

**Ontology** Ontology is a term used in slightly different ways by several academic and work disciplines. Within this book, ontology will be understood as relationships and properties between a collection of concepts and categories within a specific domain of interest.

The word ontology comes from the Greek words *ont*—‘being’ and *logy*—‘the study of’. As with metaphysics, of which ontology is a part, ontology is not an easy word to define, perhaps in part because, ontology is an aspect of metaphysics, which part which deals with the nature of being. Ontologists attempt to identify and understand what sorts of things really exist, the fundamental things that exist independently, and that compose our world. They may also attempt to answer questions such as do universals exist or is there a god. Thus, a philosophical enquiry must primarily establish an ontological grounding of what exists and what the world is made out of. The establishment of these answers constitutes a worldview.

**Partial Order Scalogram Analysis (POSA)** Partial order scalogram analysis (POSA) and its variant known as Partial order scalogram analysis with base Co-ordinates (POSAC) is a form of statistical analysis. I define in detail scalogram later in this

glossary, however at this point it is important to note that a scalogram is a psychological assessment procedure in which for a respondent to respond correctly or to be able to accomplish a task at a given level means that he or she would have successfully completed all earlier items in the assessment. POSA analyses an individual respondent's profile of on scalogram items. POSA produces a two-dimensional graphical plot of a multivariate data set which depicts each element as a point in this space. In these plots, points are located so as the point that represents item A is positioned above the point representing item B if and only if  $A > B$  (see Ravel and Landau 1993).

**Personal Construct Psychology** The psychologist George Kelly developed a personality and cognition theory called Personal Construct Psychology (PCP) in the 1950s. Constructs are personal mental measures, are bipolar and form the basis for the way we, as individuals understand the world around us. The approach has been used extensively in psychotherapy and applied in research settings. A central component of PCP is the Repertory Grid (RG) Interview (or technique). The Grid is used to explore and uncover a respondent's construct based classification system for the perception and understanding of their world. PCP and RG are respectively tools and a theoretical framework for interpreting individual world-views. Kelly stressed that we are all scientist who test our constructs in relation to our actions, where we may modify construct to achieve congruence between our mental everyday lives.

**Phrase** In language, a phrase is a small collection of words that form a conceptual unit with and idiomatic meaning and which usually are part of a clause.

**Polar Role (facet)** A polar role facet causes events to be qualitatively differentiated, ordered in terms of the facet's content. These appear as wedge shaped sections with a common origin. This is a qualitative arrangement with no ranking between regions. Another characteristic of a polar role facet is that due to the lack of ordering present no prior hypothesis exists for the arrangement of facet elements although adjacent elements will be perceived as more similar than those more distantly positioned.

**Predicate** We use the word predicate in its grammar sense. On this understanding, a predicate is a part of a sentence which contains a verb, and which has reference to the sentence's subject.

**Qualitative research** Qualitative research is research that employs non-numerical assessment criteria and yields non-numerical data. This type of research typically produces text, observational or narrative data and cannot be analysed statistically. Qualitative research typically attempts to produce rich understanding of the research context with findings that cannot be applied with confidence outside of the sample being investigated.

**Quantitative research** Quantitative research produces numerical data that may be analysed statistically. This form of research may be generalised outside of the sample used in the research with a specific level of confidence regarding the robustness of such generalisations. Quantitative data and research are typically not used to reveal respondents' rich personal meanings.

**Radex** A radex is common example of two facets playing a combined role. A radex is a facet structure formed by the combination of a non-ordered facet with an ordered facet where non-ordered structure of a polar facet combines with the wedge-like arrangement of elements from a modular facet. The result being that centrally located events are more generally related to the research domain implying that a person makes a concurrent evaluation of extent (such as importance or centrality) along with differentiations of the same content into relatively discrete and different regions. In this situation, the second facet modifies the former, and vice-versa.

**Reliable/reliability** A claim that something is reliable refers to the veracity of such an assertion over time and across instances of its occurrence. To wit, within the sciences, if an item or an event is identified reliably, its identity or characteristics will remain constant within its definition on all encounters with such an event or instance. The importance of reliability in descriptions is that a person reading a reliable depiction can be assured that this will describe the event similarly across time and place.

*Reliability has a specific meaning in the context of research. On this meaning reliability mean the consistency and trustworthiness of a measure or assessment procedure. Therefore, what is meant by reliability is the extent to which a measure will produce the same result when it is applied multiple occasions or at different times to the same sample.*

**Scalogram** The concept of the scalogram comes largely out of the work of Louis Guttman. A scalogram is a collection of questions or other means of gathering data about a given content area (see for example, Guttman 1944). What is unique about the scalogram is that after considerable testing a final set of questions or items is collected together and arranged in such a way that a positive response, accomplishing a given task, at a given level implies that all lower level tests or items would also have been positively or successfully completed. The items themselves must focus upon a single area, but they may be drawn from many domains such as being able to complete a mathematical test, being able to complete a puzzle, agreement with a series of propositions, and so on. A scalogram is a test of a cumulative ability or skill. An example would be a test of the cognitive ability of children. In this example, it would be expected that a child who could perform a mental multiplication would also be able to perform a written addition and this child would also be able to identify a pile of a given number of items from

another pile of a different number of items. In this example, a scalogram is formed where successfully performing the first task given predicts successful performance of the other tasks. This form of cumulative testing of ability has obvious benefit for use with birds that are not able to respond verbally to enquiries or report the process they go through to solve a problem.

**Semiosis** In language or literature, semiosis is the process of signification. Any form of activity that involves signs and the production of meaning and the study of the relationships between signs and the objects to which they refer.

**Sentence** A sentence is a collection of words that may be thought of as being complete in itself. Usually, a sentence contains a subject and a predicate and may express a question, statement, command or an exclamation. Sentences are usually formed so that they consist of a main clause and sometimes one or multiple subordinate clauses (see clause). Sentences begin with a capital letter and end with an end mark. A sentence expresses a complete thought.

**Set Theory** Set theory is a component of study within mathematical logic. It is the mathematical study of the properties of sets and the infinite. Sets are collections of objects (usually mathematical). Set theory aims to describe the structure of the mathematical universe through using inner models, independence proofs, large cardinals, and descriptive set theory.

**Simplex** This is the structural arrangement of an axial facet and displays a basic ordering among the items or events that are evaluated.

**Smallestspace Analysis (SSA)** Smallestspace Analysis (SSA) which has also been called Similarity Structure analysis (see, Amar and Levy 2014; Borg and Lingoes 1987) is a multi-dimensional scaling form of statistical analysis. Both of the names for the procedure are illustrative of its function as the procedure attempts to discover configuration between and of variables in a research project which are inter-correlated. Smallestspace analysis is based upon the non-metric similarities between variables which it attempts to locate within a theoretical geometric space of the fewest dimensions possible. Thus, Smallestspace Analysis is a data analysis technique similar in some ways to Factor Analysis but using non-metric rankings of items in its analysis rather than raw data as used in other techniques. The use of non-metric measures opens the potential for the use of smallestspace analysis in a more flexible manner upon data that is less stringent in terms of its statistical requirements and also open qualitative, theoretical, or philosophical judgements and estimations of similarity. The output of smallestspace analysis is a series of two-dimensional plots, the accuracy of which is estimated through a co-efficient of alienation.

**Test battery** In psychological assessment, individuals are usually tested using a variety of different, though related, tests; this is the case in the assessment of intelligence and other skills and abilities. Together, these tests are known as a test battery.

**Theory** The word theory has slightly different meanings but in this book, a theory is taken to be related to a set of ideas which are used to explain other events or things. Theories often are general in their nature and are independent to the events, states of affairs, and so on, that they are being employed to explain. In science, theories are often used in the above sense in order to explain the natural world in a manner that avails itself to investigation and verification, refutation or amendment through the process of repeated investigation of the theory's ability to provide explanations of empirical observations.

**Traditional mapping sentence** (see mapping sentence in a general sense)

**Truthmaker** The notion of a truthmaker originates and resides within metaphysical philosophy and is encompassed within concerns regarding truth and existence. Thus, the thing that confers truthbearer true is its truthmaker. In an elemental sense, this implies that this relationship “holds between any truthmaker, T, which is something in the world, and the proposition” that T exists (Armstrong 2004, 6).

**Validity** Validity refers to the instance when something is rooted in truth, fact, supported by a law, and so on. Perhaps, more directly relevant to the present writing, validity means to something that is supported by theoretical rationale or empirical evidence. Moreover, validity implicates an adequacy and appropriateness in terms of any conclusions that are derived from research or other form of assessment (American Psychological Association 2018).

Within the sciences, and within this thesis, the concept of validity refers to the legitimacy of a claim. Thus, an assertion is valid if the quantity or quality that is being referred to or measured is in reality that entity and not simply its surrogate, proxy or correlate. The importance of using valid descriptors is that a person can be assured that what is being described is the actual event of interest and not a similar temporal or spatial occurrence that may confound understanding.

**Variables** Variables are components of experimental situations and a part of the language used to talk about and describe much quantitative research. Variables are events or other entities that may be controlled, altered, or measured in an experiment. More specifically, in experiments, variables may take one of several types. Independent variables are the variables that are manipulated in the course of an experiment. Dependent variables are the outcome variables or the variables that alter due to the manipulation of the independent variables. Controlled variables are the variables that are held constant in an experiment in order to remove their effects upon the dependent variables. Extraneous variables are the variables that have an effect on the dependent variables, but are not taken into account when considering the effects of the independent variables. Extraneous variables are a source of error in an experiment.

- Visual Neuroscience** Visual neuroscience is a sub-discipline of cognitive neuroscience that takes vision as its subject. In particular, it studies the ways in which the brain enables sight, considering the role of the retina, retino-geniculate connections, visual development, comparative visual physiology, and the visual cortex.
- Voxel** The word voxel is derived from the words volume and pixel and is a value (location) within an axiomatic or regular three-dimensional grid.

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