“Revised Kantian Naturalism: Cognition and the Limits of Inquiry”

Fiona Charlotte Roxburgh

PhD Thesis

University of East Anglia
School of Philosophy

May 2011

“Revised Kantian Naturalism: Cognition and the Limits of Inquiry”

PhD Thesis Abstract

I develop a naturalised Kantian position which is tailored specifically to the notion of the conditions for the possibility of scientific inquiry. This position I call Revised Kantian Naturalism (RKN). I defend what I take to be the proper construal of naturalism, and examine the ways in which Kant’s critical philosophy must be adapted if it is to be naturalised and updated in accordance with advances in scientific theories. I defend the details of RKN, in which the conditions for inquiry are given as mind-independent principles supplied by a constitutive framework, which is in turn relative to a given stage of theoretical understanding; furthermore RKN also entails a commitment to a regulative ideal of unified science. The details of RKN are drawn from Cassirer’s ideas as well as Kant’s notion of a noumenal-phenomenal boundary, and the extent to which Kant is interested to establish the basis of the principles of scientific theories. After my defence of RKN, I apply the details to the issue of our cognitive limits and the extent to which cognitive science may be able to discern those limits; I also apply RKN to the debate between ontic structural realism and constructive empiricism, using the regulative ideal of unity as a means by which to support ontic structural realism. In both applications of RKN, the regulative ideal of unity provides a forceful and unique way of bolstering the respective positions by means of the way in which it draws together the notions of investigative optimism and intellectual humility along with the notion of unity and its central importance to scientific theorisation.

Fiona Roxburgh
UEA

Contents

STATEMENT OF LENGTH:

70 982 Words

Chapter One:
Introduction

1.1. My chief interests

In this thesis, I bring together three areas still very much in discussion within current philosophical debate, namely, Kant's philosophy, inquiry into cognition (via cognitive science or philosophy of mind) and debates about scientific realism. I propose to draw these areas together in a unique way, and by doing so, offer a distinct contribution which is relevant to all three areas of philosophy.

The study of Kant's writing is still very much of interest and recent work has focussed upon ways in which Kant's ideas may be updated; such proposals demonstrate that the questions Kant tackles, as well as his transcendental philosophy, remain significant and relevant. Hanna (2001), for instance, explores Kant's work in terms of cognitive semantics, and Friedman (1992; 2001) explores the aspects of Kant's writing which pertain directly to scientific inquiry. Hanna (2006) also develops a non-naturalistic reading of Kant's work specifically as a means by which to make sense of scientific inquiry. Such recent studies draw variously upon Kant's attention to the nature of cognition, as well as the philosophy of science which may be drawn from Kant's ideas.

Kant's focus upon cognition, and his relevance to philosophy of science, have been combined along with my interest in current issues regarding cognition. Cognitive science constitutes an area in which debate is still very much live, and in which the philosophical foundations are still up for examination (for instance: Pylyshyn 1984). I have therefore developed an interest in combining contemporary readings of Kant, in which his consideration of science is emphasised, with contemporary inquiry into cognition. As such, I start from a commitment to naturalistic philosophy. The current debate in scientific realism and structuralism draws on the issues of the reality of entities posited in the domains we establish for our inquiry (for instance, phenomena examined within the scope of cognitive science), as well as calling to light the very notion of an explanation as to why scientific inquiry should be successful in the first place. Consequently, these debates hold great significance for the concerns of this thesis and for philosophy of science in general.

Throughout his writing, Kant may be characterised as upholding a distinctive intellectual modesty towards investigation, whilst simultaneously exploring the notion of unity at the basis of judgement and experience. Both the notion of unity, as a regulative ideal, and the methodological attitude of investigative modesty, are also at the foreground of current naturalistic positions, and within the debates surrounding structural realism and the success of scientific inquiry. The themes of investigative modesty, optimism within naturalistic inquiry, and the regulative ideal of a unified science, therefore hold across all three of the areas which I intend to bring together.

1.2. Chapter summaries

In the remainder of the introduction, I shall provide detailed abstract summaries of the chapters in this thesis. The first three chapters (chapters 2 to 4) develop and defend a Revised Kantian Naturalism (RKN), which is intended as a naturalised application of Kant's philosophy as specifically applied to the notion of scientific inquiry, and updated in accordance with developments in science that have taken place since Kant's writing. Subsequently, chapter 5 and chapter 6 tackle two areas in which RKN is usefully applied.

In chapter 2, I mount an argument for what I take to be the proper construal of naturalism, and consider the extent to which Kant's philosophy (for instance, within the *CPR*)[1] may be naturalised. The first half of the chapter supplies my defence of naturalism, in which the position defended is Chomsky's methodological

[1] From here onwards, I use *CPR* to refer to the first *Critique* (Kant 1781/2003).

naturalism (Chomsky 2000). Given the focus upon cognition, I consider the so-called naturalistic approaches to the philosophy of mind, offered by various physicalist positions and Quine's (1969) naturalised epistemology. I explain and defend specific criteria for methodological naturalism, drawing upon examples from the study of language as a specific sub-section of the study of mind; in the course of the discussion I demonstrate the ways in which other varieties of naturalism (such as those adopted by physicalists) fall short of the required criteria.

A particular theme highlighted by the discussion of the respective physicalist positions is the concern about how the taxonomy of the study of cognition relates to the terminology used in other branches of science; such a concern may be framed as the question of how we should carve out categories within the domain of the mental for the purposes of naturalistic inquiry. The notion of the appropriate sub-categories of cognition will recur in chapters 5 and 6.

A further theme addressed by the argument for naturalistic inquiry is the notion of unity in science; an ideal notion of scientific unity will be prominent throughout the subsequent chapters, and in chapter 2, the hope for a unified science (or in other words, the notion of a regulative ideal of the unity of a completed science) is explicitly defended as a properly naturalistic idea.

Having defended methodological naturalism, in the first half of chapter 2, I begin my defence of a naturalised reading of Kant's philosophy. My reading focuses specifically upon those aspects of Kant's ideas pertaining to scientific inquiry or philosophy of science, rather than upon a standard reading of Kant's overall investigation of metaphysics and epistemology. I defend such a choice of focus (i.e., Kant's concern with the conditions for the very possibility of scientific inquiry), and demonstrate the way in which such a specified adaption nonetheless preserves the very spirit of Kantian critical philosophy. I address the potential difficulties that face any attempt to naturalise Kantian transcendentalism, and establish the fact that in order to maintain such an approach to the conditions for scientific inquiry, we must recognise a much broader notion of what such "conditions" amount to. I articulate a revised "Kantian Question" which expresses the element of Kant's philosophy that I wish to retain; I examine the extent to which cognition may be thought to play a role in the set of conditions which make scientific inquiry possible. Very briefly, I introduce the idea that the cognitive skills which contribute towards inquiry must be made distinct from the full set of whatever conditions allow for scientific theories to develop and progress. Such a distinction is maintained and developed in subsequent chapters. I end the chapter by indicating those areas in need of attention for the development of a RKN.

In chapter 3, I examine in more depth how such a Revised Kantian Naturalism may be developed. In keeping with the naturalistic criteria provided in chapter 2, I examine the extent to which Kant's specific ideas for the conditions of possible experience are affected by advances within physics, since Newton's work. Given the emergence of non-Euclidean geometry and Special Relativity, Kant's philosophy faces significant hurdles if it is to be naturalised and therefore kept consistent with scientific advances. I argue that, on the basis of such scientific developments, the conditions for the possibility of scientific inquiry may no longer be cognitively determined in the way proposed by Kant (*viz*., principles derived from aspects of our cognition. I defend a construal of such conditions as a set of theory-relative principles which form the constitutive basis for a given theoretical explanation, based on the ideas put forward by Cassirer (1910/2003; 1921/2003) and emphasised by Friedman (2001). The principles which may be characterised as both relative and *a priori* form a constitutive framework as the seat of the set of conditions for the respective scientific theory; I defend the notion of such a constitutive framework first with reference to Newton's theory of gravitation, and subsequently with reference to Einstein's Special Relativity.

In addition to the constitutive framework, which may be revised with theory change, a regulative principle of unity (Cassirer 1921/2003) grounds the relativized *a priori* principles, and provides the foundation against which any principle may be so much as possible. In the course of the discussion of Special Relativity, I emphasise the coherence upheld across the process of theory change, which is made possible by the notion of a constitutive framework. It is by virtue of the possibility of revising the framework itself that coherent theoretical shifts are made possible; equally crucial, however, is the idea that Cassirer's regulative principle forms a proper part of each framework whilst also persisting across periods of theoretical revolution or change. The notion of continuity across theory change is therefore emphasised, and the importance Einstein places, upon the symmetry of scientific theories, is highlighted as an example of how scientists themselves explicitly anticipate and seek out such an ideal unity. The combination of the constitutive framework, as an alternative set of conditions for scientific inquiry, and the principle of unity, defines the position I defend throughout chapter 3, namely RKN.

In chapter 4, I mount the argument that Cassirer's regulative principle is a distinctly Kantian notion, and may be characterised as an adaptation of Kant's noumenal-phenomenal boundary, in its role as a regulative boundary notion. I offer a naturalised formulation of the argument for the very idea of the "unconditioned" as such a boundary notion. Against this backdrop, I defend the notion of Kant's noumenal-phenomenal boundary as the correct construal of the noumenal; I argue that the noumenal-phenomenal boundary is a regulative boundary notion, which therefore resists the criticisms often levelled at the noumenal. My argument draws upon Cassirer's (1918/81) reading of Kant and demonstrates that the full force of Kant's critical philosophy emerges and develops across the *CPR*; as such, the fully developed notion of the noumenal-phenomenal boundary is properly discovered only through attention to the detail of the regulative *a priori* principles of the Ideal, and of the role of Reason in the second *Critique* (Kant 1788/2004) and third *Critique* (Kant 1790/2000).

On the basis of the noumenal-phenomenal boundary as a regulative boundary notion, I develop an equivalent construal of the regulative ideal of a unified science, in accordance with the particular focus I take towards Kant's philosophy; I call this regulative ideal for scientific inquiry the Regulative Boundary (RB), and defend the idea that the RB is precisely the regulative principle that Cassirer uses (1910/2003; 1921/2003). The RB is therefore grounded in its specific application to science, as a principle used explicitly by scientists when forming theories, and also as a distinctly Kantian idea; consequently, the RB forms a crucial component of RKN, alongside the constitutive framework.

After RKN is established in chapters 2-4, I turn in chapters 5 and 6 to two areas to which RKN (in particular the RB) is usefully applied. In chapter 5, I consider the notion of a problem-mystery distinction, and two examples from philosophy of mind and cognitive psychology where a demarcation of such a distinction is offered. The first is McGinn's (1993) idea that consciousness must be mysterious, and the second is Chomsky's suggestion that we might find a Science Forming Faculty (Chomsky 1988a; 2000) as a part of our mental architecture that could facilitate a sharper demarcation of the boundary between problems and mysteries. I argue that neither suggestion is successful in securing a firmer constitutive problem-mystery distinction, and that the RB embodies the purely regulative demarcation as the only legitimate construal. Consequently, the RB may be characterised precisely as such a regulative problem-mystery distinction; if held up to the notions given by Chomsky and McGinn, the RB helps to illuminate further paths for inquiry. We can also see that the RB precisely exemplifies the very methodological principles upon which Chomsky's suggestion is given in the first place. Consequently, the RB draws out the fruitfulness of the idea of the Science Forming Faculty.

In my final chapter (chapter 6), I argue for the preference of ontic structural realism over constructive empiricism. Again, as with chapter 5, whilst the argument may be given independently, the RB provides a unique and fruitful way of bolstering the position I wish to defend, by drawing together the salient issues of the regulative unity of science. I consider the merits of constructive empiricism and establish that such benefits are also supplied by ontic structural realism, where the latter also accounts for the inherent modality of scientific theories and upholds the notion of unity within science. Subsequently, by supporting ontic structural realism with the RB, we may understand ontic structural realism as a quasi-Kantian position, to the extent that RKN is a properly Kantian and naturalistic position.

Chapter Two:
The Very Possibility of a Kantian Naturalism

2.1. Introduction

My interest in foundational issues of cognitive science means that I start from a naturalistic approach to the mind. My concern is therefore with Kant's philosophy to the extent that it can be updated and brought alongside cognitive psychology and the philosophy of science.

In order to spell out the details of this modified or quasi-Kantian naturalism, in this chapter I shall defend what I take to be the correct construal of naturalism and subsequently demonstrate how a specific understanding of aspects of Kant's philosophy may be adopted as a legitimately naturalistic approach.

2.2. Potential candidates for naturalism

2.2.1. Physicalism and metaphysical naturalisms

The term "naturalism" covers a range of varying construals.[2] The overarching idea can be summarised as something like 'philosophy's continuity with the natural sciences' (Baldwin 1993, 172), as a starting point.[3] Upon this preliminary construal, naturalistic inquiry just amounts to scientific inquiry; naturalism in philosophy, then, is a commitment to adhere to, or respect, scientific approaches, letting science guide

---

[2] The same point is made by various philosophers: (Baldwin 1993, 171); (Bontly 2001, 44); (Papineau 1993, 1); (Strawson 1985, 1); (Tye 1992, 421).

[3] Similar and equally broad definitions characterise naturalism as 'the continuity of philosophy and empirical science' (Papineau 1993, 2), and the claim that 'philosophical accounts of our minds, our knowledge, our language must in the end be continuous with, and harmonious with, the natural sciences' (Dennett 1984, ix).

our epistemology, metaphysics and so on.[4] I shall commit to this definition throughout, but far greater detail is required.

Methodological naturalism (MN) is the construal of naturalism that I wish to endorse, as the approach in which we ‘may simply adopt the standard outlook of modern science’ (Chomsky 2000, 76). MN can be defined in contrast to methodological dualism, as well as in terms of the set of positive criteria for MN. Methodological dualism constitutes an implicit or explicit assumption, prior to any investigation, that inquiry into the mind ought to necessarily be characteristically distinct from the basic methodological attitudes of the other sciences.[5] Methodological dualism is, therefore, ‘the view that we must abandon scientific rationality when we study humans “above the neck” (metaphorically speaking), … imposing arbitrary stipulations and *a priori* demands of the sort that would never be contemplated in the sciences’ (ibid., 76).[6]

In §2.2, I shall consider the merits of epistemological naturalism and metaphysical naturalism, and of physicalism as a naturalistic position.[7] Whilst initially attractive, all lead to methodological dualism. I shall defend MN in §2.3, by drawing out its positive criteria and simultaneously arguing against the acceptability of methodologically dualist positions. As a part of this process, I shall also demonstrate that MN is consistent with the naturalistic approach taken by Ladyman and Ross (2007).[8]

---

[4] We should distinguish between naturalistic philosophy and naturalism *qua* science, just so as not to classify philosophy as a distinct field within the sciences. Where the line is to be drawn between “philosophy” and “science” is not especially important; I simply wish to avoid doing disservice to either philosophy or science, by failing to recognise the difference between the two domains of inquiry.

[5] Whilst methodological dualism is a trend identified primarily within philosophy of mind, MN is an approach applicable to any area of naturalistic inquiry.

[6] The terms “methodological naturalism” and “methodological dualism” are borrowed from Chomsky (2000, 76). My argument for MN, and against methodological dualism follows Chomsky’s argument (Chomsky 2000, chapter 4; 1993, 39-42). C.f.: (Chomsky 2003, 263-269); (Collins 2010); (Poland 2003).

[7] Such varieties of naturalism are proposed, for instance, by Baldwin (1993, 172-3). C.f.: (Chomsky 2000, 79).

[8] Ladyman and Ross provide a naturalisation of metaphysics, rather than an account of what naturalistic inquiry should be *per se* (Ladyman and Ross 2007, chapter 1). Even so, their ‘naturalistic metaphysics’ (Ladyman and Ross 2007, 1) is distinct from metaphysical naturalism as discussed in this chapter, and still provides an informative understanding of naturalism, compatible with MN (c.f.: Ladyman and Ross 2007, 30).

Baldwin's metaphysical naturalism consists in the stipulation that our metaphysics should be determined or constrained by scientific understanding; a naturalistic theory of mind should (according to Baldwin) in some sense encompass our understanding of the physical, in a rejection of substance dualism. In other words, 'a naturalised philosophy of mind should abjure explanations … that are detached from the great chain of physical being' (Baldwin 1993, 173). What is meant by explanations which are a part of "the great chain of physical being" is not immediately clear (Chomsky 2000, 81-2). "Physical" could refer to our common-sense notion of the material or to the focus of physics; either way, the idea seems to be that the conception of the mental should be aligned with some notion of "matter" so as to retain a sense of 'unified self-understanding' (Baldwin 1993, 173). In other words, metaphysical naturalism appears to amount to a commitment to physicalism.

Physicalism has been defined just as naturalism (Burge 1992, 31), or as a specific 'strand' of naturalism (Papineau 1993, 1).[9] In opposition to substance dualism, physicalism does not entail a particular philosophy of mind but consists of a range of positions which purportedly bring scientific understanding to bear upon philosophy of mind.[10] I am not concerned with the particular arguments for one or another physicalist theory of mind, but rather in the foundations of physicalism itself as a broad methodological approach or attitude.

Strict type identity initially constituted reduction of the mental to the physical,[11] but whilst hugely influential, type identity theory was short-lived (Kim 1998, 2).[12] After the work of those such as Kuhn (1962/96), who brought to light the difficulties with reductionism, anti-reductionist positions have been widely endorsed, both within philosophy of science and philosophy of mind.[13] Many physicalist positions are grounded upon a so-called naturalistic disavowal of both substance-

[9] Tye makes a similar point, whilst acknowledging that functionalism and behaviourism need not be regarded as strictly physicalist positions, though neither position endorses substance dualism (Tye 1992, 422).
[10] For a detailed inspection of prominent physicalist theories of mind, see: (Kim 1998). C.f.: (Papineau 1993).
[11] For an over-view of such reductionism, see: (Oppenheim and Putnam 1958).
[12] Kim (1998, 2), for instance, credits Smart (1959) and Feigl (1958) with the instigation of type physicalism, whilst also acknowledging the importance of Place (1956).
[13] Ladyman and Ross make this point, proposing that there is an 'almost universal rejection' of Oppenheim and Putnam's reductionism (Ladyman and Ross 2007, 47).

dualism and scientific reductionism. Certain physicalist theories therefore build upon and attempt to account for the perceived qualitative distinction between the mental and the physical, where such a distinction is taken to ground the need for unique terminology at the various different levels of inquiry.

The essential idea to anti-reductionism is as follows.[14] Highly useful explanatory insights are available at a localised level that is unrecognised by the theories of fundamental physics. Fundamental physics (potentially) takes the whole of the universe as the relevant domain; more localised fields of inquiry take a specific sub-category of the universe as their domain.[15] For instance, human medical biology applies to the human body, and does not concern the laws of planetary motion. Where fundamental physics might be capable of describing some of these non-fundamental domains, much more efficient explanatory theories are generated by working in terms which do not account for phenomena lying outside the domain in question. For instance, if one were interested in (say) the biochemistry of rats, an explanation at that level of locality would be far more efficient than an explanation using (say) particle physics. The terms and constructs of particle physics account for way more phenomena, at larger scale of inquiry, and would far exceed the requirements for a sufficient theory of any rat biochemistry, rendering inefficient any such theory relying unnecessarily on the taxonomy from physics.[16]

The notion that different levels of description demand different sets of explanatory terms is a widely endorsed view. Cognitive scientists such as Pylyshyn argue that:

> [i]t is an empirical fact about some behavior of humans and other animals that the regularities we are primarily interested in cannot be expressed listing certain biological and physical descriptions. […] Perhaps it is not surprising

[14] A full review of reductionism and anti-reductionism is tangential to this chapter. For arguments against reductionism see: (Kuhn 1962/96); (Ladyman and Ross 2007, 45-53, 190-6 and 239-57). For an argument against reductionism in philosophy of mind, see: (Fodor 1975, 1-26).

[15] The distinction between fundamental and non-fundamental science need not be a clean-cut division between physics and other sciences. I follow Ladyman and Ross in their demarcation, whereby the set of special sciences contains all scientific fields in which the relevant domains (for which measurements are taken, and over which generalisations are made) are restricted, specified sections of the universe, or are demarcated at restricted scales (Ladyman and Ross 2007, 195). Some aspects of physics, therefore, will count as a part of the special and not fundamental sciences.

[16] C.f.: (Ladyman and Ross 2007, chapter 4). C.f.: chapter 6, especially §6.4.3.

> that strikingly different regularities emerge under different descriptions of events, and consequently that the descriptions suitable for stating the regularities of physics, chemistry, and biology are unsuitable for stating the regularities of cognitive psychology.
> (Pylyshyn 1984, 17-8).

Fodor, too, explains the need for different taxonomies for different types of entities or generalisations; whilst we may be able to establish some sort of cross-classification between taxonomies, Fodor suggests, 'it is not further required that the taxonomies which the special sciences employ must themselves reduce to the taxonomy of physics' (Fodor 1975, 25).[17] An alternative taxonomy is therefore taken to be appropriate for the domain of the mental, and the often-perceived challenge for the physicalist is to account for the physical basis of the mind from a non-reductive but non-dualistic position, from within the set of conceptual terminology which is specific to mental phenomena.[18]

Strawson, for example, advocates an alternative to the identity thesis (1985, chapter 3), whereby differing (but self-sufficient) explanatory systems are recognised as equally legitimate. According to Strawson, we can describe the events involving a given individual from a phenomenal and personal standpoint, or from a scientific perspective (via neurophysiology and biology, for instance). The two different types of explanation (or "story") are both valuable for the respective areas of interest, and both are equally meaningful and complete, by their own terms. Whilst an entirely physical description would theoretically be possible for such an event, the scientific story 'leave[s] out almost everything that … [is] humanly interesting' and this is why our "personal" language is still so necessary (ibid., 56). The terms of one story do not translate into the other, in any informative or enlightening way, because the account of a person's behaviour or mental state 'belongs firmly to the personal story … which … is answerable to a set of constraints quite discrepant from those which govern … the complete causal story of the purely physical organism' (ibid., 63-4). Both the physical and personal accounts of events are entirely compatible with one another (and so with physicalism), and trouble only arises when we try to establish an 'interface' between the two types of account because no such interface or

[17] C.f.: (Ladyman and Ross 2007, chapter 4); (Pylyshyn 1984, 16-21).
[18] See, for instance: (Davidson 1970/80, 207); (Place 1956, 44).

alignment may be had, and which would not be illuminating in any case (ibid., 61-2). Just because some aspect of our phenomenal personal life interacts with the physical world does not mean that there is some correspondence theory about the two different systems of description. Strawson, therefore, draws upon the concerns with a reductionist theory of mind, recognising the utility of distinct taxonomies.

Other physicalists assert an even stronger qualitative difference, whereby the domain of the mental is not merely usefully described, but necessarily described, by a distinct set of terms.[19] Davidson endorses the thesis that, whilst all events are essentially physical, the mental cannot be explained in purely physical terms or be reduced to physical laws. The non-equivalence of the types of laws for physics and for mental phenomena respectively is the foundation of Davidson's claim that there are no psychophysical laws (Davidson 1970/80, 214-6); c.f.: (Davidson 1973/80; 1974/80, 230-1). Mental phenomena may be explained by generalisations that take the 'logical form of a law … [yet] are not *lawlike*' (Davidson 1970/80, 216). Calculating planetary motion, for instance, yields far greater predictive accuracy than is achieved when we try to predict a person's response to the stimulus of hearing the words "there's been an accident; get help!" Human actions, let alone thoughts (or responses to one's thoughts) are not lawfully predictable in the same way, or to the same degree. In other words, a human's response to linguistic stimulus, or to their own thoughts, is underdetermined (Chomsky 1959); (Collins 2008, 84); (Pylyshyn 1984, 4-5). The causal efficacy of a person's thought-life upon their physical actions appears, therefore, as though it is not amenable to generalisation under the terminology of physical science (at least not to the same degree of accuracy and precision, as given by the laws of physics).

Papineau makes a similar point, starting from a definition of physics as a self-sufficient closed system (Papineau 1993, 16-7); he explains that, for mental phenomena, 'special categories cannot even in principle be specified in physical terms. Nevertheless … such special terminology is still just a way of describing complexes of physical stuff, and does not require us to recognise any non-physical

[19] Another example of a supposed qualitative difference is the phenomenon of consciousness, which philosophers have sought to reconcile with brain processes (c.f.: Place 1956); others who do not ascribe to physicalism suggest that consciousness is beyond any kind of naturalistic explanation (c.f.: Nagel 1974).

substance' (ibid., 13). Papineau distinguishes between the terms of physics and of the other sciences, pointing out that physicalism recognises a world:

> constituted by physical facts, by particles and fields in motion through space. At this basic level all facts can be described by strictly physical terminology, like 'mass', 'energy' and 'position'. However, physicalism … [also] allows that we often use non-physical terminology, like 'sulphuric acid', 'thunderstorm', 'elephant' and 'thinking of the future', to group and categorize large-scale arrangements of physical facts.
> (ibid., 13).

So far, motivations for physicalism appeal to well-established concerns for the avoidance of reductionism.

2.2.2. Epistemic naturalism

The term "epistemic naturalism", borrowed from Quine (1969), can be thought of as an initially 'uncontentious' notion (Chomsky 2000, 80) whereby we accept epistemological naturalism just as naturalism; c.f.: (Chomsky 1993, 42).[20] The term, however, is problematic. Given that this is a specifically epistemic naturalism, and given that "naturalistic" positions typically belong to philosophers (and not scientists), the implication is that epistemological naturalism provides some plausible alternative to straight-forward naturalism (i.e., a scientific approach).[21] It is unclear what a specifically epistemological naturalism should involve, in distinction from naturalism *per se* (Chomsky 2000, 81). After all, science is centrally involved with our body of knowledge, and is therefore automatically of epistemological importance. We see no reason to specify an epistemological science; as naturalistic inquiry just is scientific inquiry, it is equally unnecessary to qualify naturalistic inquiry as "epistemological", as the latter descriptor is rendered superfluous.

Having established that we may refer to naturalism as opposed to epistemological naturalism, it remains to be seen whether Quine's position, endorsed under this name, provides a fruitful construal of the notion. Quine's philosophy of

[20] Chomsky, however, does not endorse the detail of Quine's specific naturalism (Chomsky 1993, 32).
[21] Quine may have coined the term so as to indicate a naturalistic approach towards to epistemology, rather than a naturalism which is epistemological in character (Quine 1969). Even so, the distinction between epistemological and other alternative types of naturalism remains vague.

mind may be construed as emerging from his scientific holism. Quine is credited with rescuing philosophy from the difficulties that faced logical positivists (Burge 1992, 6), and is also said to have 'saved the philosophy of language as a serious subject' by dissolving the analytic-synthetic distinction (Davidson 1984/86, 313); c.f.: (Rorty 1986, 339). Quine's success in doing so, along with his criticisms of verificationist approaches to science, allowed the development of scientific holism and, in turn, Quine's approach to language.[22]

According to Quine, 'epistemology … simply falls into place as a chapter of psychology and hence of natural science' (Quine 1969, 82). In other words, we can look to natural science 'for an account of what there is' (Quine 1992, 9); philosophy is therefore answerable to our best scientific understanding. Quine rejects both the analytic-synthetic distinction and the semantic reductionism of logical positivism. For such semantic reduction, the meaningfulness of a proposition is dependent on a one-to-one mapping onto the truth or falsehood of a state of affairs in experience. Quine demonstrates that there is no such straight forward relation between a sentence taken in isolation, and the sentence's meaning (i.e., its truth value), due to the importance of context in the development of meaning (Quine 1951/64, 38). Upon this basis, he develops an alternative subtler account of semantics, whereby meaning is grounded on a holistic model of semantics. A holistic view of science, and of the meaning of sentences within that science, must therefore be taken in order to develop an adequate model of semantics (especially regarding scientific confirmation); in other words, the process of scientific confirmation does not involve establishing the meaning (and therefore truth value) of isolated statements, but is to be conducted by approaching the full body of scientific claims as a whole (ibid., 42).

According to Quine's holism, any sharp distinction between language and experience is dissolved. On Quine's account, epistemology is, therefore, subsumed under linguistics. As Quine takes linguistics to be concerned with the stimulus and output of verbal behaviour (Quine 1969, 89), Quine's naturalistic philosophy rests upon a behaviourist model of language and psychology, which behaviourism Quine explicitly promotes as 'mandatory' in linguistics (Quine 1990, 37). As a result, if

[22] For an example of such work, see: (Quine 1951/64, 1969). C.f.: (Quine 1960, chapter 1). See also: (Burge 1992, 3-12).

specifically epistemological naturalism is to mean anything more distinct than naturalism itself, according to Quine, then the philosophy of the mind reduces to behaviourism.

In §2.3, I shall defend the specific criteria for MN, against methodologically dualistic approaches. I shall argue that, despite some worthwhile motivations, the physicalist and behaviourist positions considered in §2.2 do not measure up to the requirements of MN, and exhibit the characteristics of methodological dualism.

2.3. Methodological naturalism

2.3.1. Criterion one: following the lead of science

In this section I shall defend six definitive features of MN, and in doing so shall examine whether the previously considered physicalist positions measure up to the various criteria.

The first requirement of MN is that we take into account whatever science has shown us so far; this idea follows simply from the preliminary definitions already given. With regard to physicalism, we should therefore look to science for our understanding of the physical. A corollary of the first criterion is that the mind-body problem is not sufficiently formulated as a serious investigative issue.[23]

The mind-body problem rests upon some significant contrast between the nature of the "mental" and of the "physical". But an examination of the scientific development in physics shows that Descartes' formulation of the problem was dissolved with Newton's physics, way before Ryle set out to disabuse philosophers of the illusion of the ghost in the machine (Ryle 1949/63). Descartes formulated the mind-body problem according to the physics available at the time, whereby "bodies" were understood in terms of contact mechanics; he aimed to align the specific notion of "body" with the notion of "mind" which evaded illumination or explanation under

[23] For the present section I follow Chomsky's argument (Chomsky 1988, chapter 5; 1993, 36-9; 2000, 79-93 and 108-112). C.f.: (Bilgrami and Rovane 2005); (Chomsky 1968/72, 12-4).

the available mechanics. Descartes therefore posited the distinct substance of the mental in order to account for properties that could not be explained by the available mechanistic laws (for instance, the spontaneous generation of new thoughts).[24]

The explanations in contact mechanics were replaced by Newton's theory of gravity, which introduced the notion of action at a distance. In classical physics, the forces studied were no longer restricted to contact-based action, which subsequently undermined the older conception of "body". Without a clear demarcation for the "physical", no clash arises between the two notions and so no explanation of their cohesion is called for; in other words, there is nothing against which the notion of "mind" may stand in contrast.

Descartes' approach to the mind made sense in light of the stage of physics at his time; we have progressed in physics far beyond that level of understanding, but certain theories of mind nonetheless implicitly draw upon a notion of "body" grounded in 17th century mechanics, 'an approach that is foreign to the methods or concerns of the sciences' (Chomsky 1993, 37). The mind-body distinction simply 'cannot be formulated ... except as a terminological device to distinguish various aspects of the natural world' (ibid., 40).

Two significant consequences emerge from the shift to classical physics, regarding naturalism of the mind. First of all, the mind-body distinction collapses, as 'Newton eliminated the problem of the "ghost in the machine" by exorcising the machine; the ghost was unaffected' (Chomsky 2000, 84); c.f.: (Chomsky 1993, 38). In addition, a sharp distinction emerged between our common-sense or phenomenal understanding, and our scientific theoretical accounts. Although physics has developed beyond the classical theories of Newton, contemporary physics reinforces both the departure from common-sense understanding (or folk physics) and the dissolution of a theory of "body". Special and general relativity theories (let alone quantum mechanics) hardly provide us with a firmer fixed definition of the "material". Three-dimensional space-time, as it turns out, is curved; theoretical concepts have become relative, and are no longer the stable invariant ingredients of a

[24] Consequently, Descartes' approach was in fact entirely naturalistic (Chomsky 2000, 108).

physical theory. Contemporary physics has therefore continued to reinforce the two results of Newton's discoveries.

In light of the consequences detailed above, the positions detailed in §2.2 may be assessed. We can make sense of a specifically metaphysical naturalism only if we have a clear understanding of the distinction between mind and body. As no such distinction is the case, a specifically metaphysical naturalism remains unclear, at best, and must be rejected as a candidate for a naturalistic position.

The persistent belief that the mind is qualitatively different to physical matter (which belief contains the implicit or explicit idea that we somehow have a clearly demarcated concept of matter or body) amounts to a claim which fails to respect the lead of science. Instead, such beliefs appear to be grounded on the Cartesian understanding. Even where no direct reference is made to Cartesian construals, consideration of the concept of body, according to classical physics, brings to light the fact that (at the very least) the relevant advances in physics have not been sufficiently respected within physicalist approaches to the mind.

For instance, recall that Papineau distinguishes between co-called physical terms, and non-physical terms such as "elephant" (presumably a term of biology); living organisms fall into the non-physical category, and so human bodies would presumably also be categorised as non-physical. No distinction obtains between the bodily and the mental according to Papineau's own definitions, because both are described in non-physical terms. Even so, he wants to retain this sharp distinction between the mental and the physical.

In a similar way, Davidson's assertions that there are no so-called psychophysical laws (Davidson 1970/80, 225), and that psychological phenomena 'resist incorporation into closed deterministic system' (Davidson 1974/80, 230), amount to claims that the types of laws produced to account for mental phenomena are necessarily different from those of physics. In other words, the theories and generalisations of one field of science are not of the same nature or type as those of another field. For a generalisation to be lawlike, Davidson explains, is for it to be drawn 'from a comprehensive closed theory' (Davidson 1970/80, 219), where such a closed theory is one which is not dependent on any terms, components or aspects of a different theory. Another way of putting this is to say that a closed theory will be a fundamental theory; any non-fundamental theory with a more localised domain will never be entirely self-sufficient and will, to that extent, be dependent upon terms or components of a more fundamental theory. Human biology constitutes another scientific field which establishes rigorous but non-fundamental theories; i.e., it is not a comprehensive closed system. The alignment of the mind and body would constitute the unification of two non-fundamental fields, neither of which is a closed system. On Davidson's criteria, biology can be no more lawlike than the mental.

For both Papineau and Davidson, all we are left with is a set of ways in which to distinguish different domains of phenomena that we wish to study. How these domains might eventually be unified is quite another question, and not one which is specific to inquiry into the mind. To use the difference between domain-specific taxonomies in order to motivate or characterise the mind-body distinction relies on a category distinction which was long ago dissolved; this, in turn, amounts to a methodologically dualist position, and it is precisely such a methodological dualism which renders physicalism unfit to act as a naturalistic approach, according to the criteria of MN.

2.3.2. Criterion two: freedom from concerns of future unification

The prospect of future unification shouldn't restrict or determine how we specify domains or draw parameters for our present inquiry. For a start, we do not know as yet what it is that should ultimately be unified (Chomsky 2000, 107); our capacity to achieve such an integrated science 'is a question of fact, not dogma' (Chomsky 1993, 42), something which remains to be seen about the world and not something about which we are at liberty to make *a priori* claims; c.f.: (Chomsky 2000, 82; 2003, 264). We may proceed with inquiry into the mind, and hope for its integration with other sciences at some point, letting unification follow (if and when it can) in accordance with what future investigation reveals.[25] Trying to ensure that any new

[25] In a choice between Theories X and Y, the cohesion of Theory X with an already-established theory, in another field (for instance), may act as a deciding factor, but it is by no means a necessary one.

theory is unified with pre-existing theories would at best be inefficient; at worst, it would amount to the *a priori* claim that the pre-existing theory will never be subject to revision or improvement.

In addition, anticipating the future unification of a given scientific field is not a practise upheld within the sciences. Had the possibility for future unification been taken as a requirement for scientific progress in the past, much advancement could have been prevented or delayed. General relativity and quantum physics, for example, have not yet been unified, but no one takes that as a good reason to discard one or the other, or as a reason to assert that quantum physics should not have been developed to begin with.

MN therefore only requires concern for potential unification, with regard to the mind, to the same extent that such concern is found for other areas of inquiry which have not yet been unified. Human biology has neither been aligned with nor reduced to quantum physics, to my knowledge, and this is not treated as a cause for concern. Where philosophers identify differences between the explanatory concepts of mental phenomena, and of physics respectively, they merely succeed in pointing to the fact that the two domains are not yet unified. Any further inference to the stronger stipulation that lack of unification generates a special problem for mental phenomenon in particular, is a methodologically dualist claim, in breach of MN.

The present criterion constitutes a further reason to reject metaphysical naturalism precisely because the latter position requires us to understand how the domain of the mental is unified with other scientific fields; in other words, metaphysical naturalism explicitly entails methodological dualism. Davidson's claims about the distinction between the terms of physics and the terms describing mental phenomena may be accepted only to the extent that Davidson simply aims to articulate the lack of unification; but such a point is not especially illuminating, and is not particular to mental phenomena (Chomsky 2000, 138). The mind-body distinction just isn't useful, except as a means of terminologically indicating different domains for inquiry.

The more positive aspect to this characteristic of MN is that we may still aim for the notion of scientific unification as a guiding principle, where the hoped-for unification needn't require any reductionist approach (ibid., 82 and 106); c.f.: (Collins 2010, 45); (Ladyman and Ross 2007, 45-53). Such a guiding heuristic does not guarantee that we will achieve unification. Insofar as a regulative ideal for a completed unified science constitutes a metaphysical proposal, this would only be a problem if it were a constitutive claim. As a result, we can understand MN as compatible with Ladyman and Ross's naturalism (2007); in addition, inquiry into the mind is allowed to proceed using its own terminology.

A central component of Ladyman and Ross's naturalistic position is that it endorses the same criteria spelled out for MN, as well as two additional principles, namely, the 'Primacy of Physics Constraint', i.e., the PPC (Ladyman and Ross 2007, 44), and the 'Principal of Naturalistic Closure', i.e., the PNC (ibid., 37-8). The PNC demands that only metaphysical claims which posit the unification of two scientific hypotheses, and which are motivated solely by the aim of 'jointly explain[ing] more than the sum of what is explained by the two hypotheses taken separately' (ibid., 37). The PPC is usefully defined in the following passage:

> Special science hypotheses that conflict with fundamental physics, or such consensus as there is in fundamental physics, should be rejected for that reason alone. Fundamental physical hypotheses are not symmetrically hostage to the conclusions of the special sciences.
>
> (ibid., 44).

The PPC and PNC may appear to violate MN, in that a degree of metaphysics is introduced, and in the fact that both principles concern the issue of future unification, but some brief attention to further detail demonstrates that no such inconsistency or violation obtains.

The PPC endorses the rejection of those hypotheses which violate fundamental physics; this endorsement, however, does not entail an approach specifically guided or tailored to by concern for future unification. All that is proposed is that we let our best science, that of fundamental physics, lead the way; such a minimal claim requires only a lack of contradiction. Furthermore, the PPC is justified on the basis that the principle is one followed by scientists and must thereby be respected by philosophers, according to the present criterion of naturalism (ibid., 44). Such requirements simply restate the first criterion given here. The very notion of restraints imposed by physics, upon non-fundamental sciences, does not violate MN, because the restriction issues from the institution of science itself, and not from philosophy (in other words, the demand is based upon the results of centuries of inquiry, and not merely upon a naturalised methodological approach taken by philosophers).

The PNC endorses unification, but again, via a principle which is designed to constrain the metaphysician and not the scientist; essentially, the PNC requires that any metaphysical claim about unification is motivated by physics itself. In other words, our best scientific understanding is to lead the way. Another way of understanding the PNC is that it is entirely compatible with naturalism to maintain the regulative ideal of unified science, and it is also a principle also actively respected by scientists.[26]

We are permitted to inquire into the mind using the distinct taxonomy appropriate to that scale of investigation, without the need to characterise the difference between domains (e.g., of cognitive science and biology), *qua* a mind-body problem. Rejection of the physicalist mind-body distinction does not entail a rejection of the anti-reductionist concerns for distinct terms of inquiry. The freedom given to the terminology allows study of the mind to begin with an abstract architectural understanding of the relevant processes.

2.3.3. Criterion Three: no assumptions about naturalistic tractability

Insofar as there is any common initial attitude within the sciences, the same set of preliminary methodological assumptions should be held for new areas of inquiry (i.e., language and mind) as for existing domains, according to MN. Differences in methodology, therefore, should emerge from inquiry. As Chomsky emphasises:

> human cognitive systems, when seriously investigated, prove to be no less marvellous and intricate than the physical structures that develop in the life of

[26] Chomsky notes that unification is a ‘persistent goal’ within science (Chomsky 2000, 82).

> the organism. Why, then, should we not study the acquisition of a cognitive structure such as language more or less as we study some complex bodily organ?
> (Chomsky 1975, 10).

The founding principle is that inquiry should lead the way, regarding any claims about whether a given area is suitable for naturalistic investigation (i.e., whether it is naturalistically tractable). If we were to assume *a priori* that a given area is intractable to scientific inquiry, until proven otherwise, then science would be potentially self-defeating: investigation could be halted before any such proof is obtained. Naturalism might turn out to be unsuitable for a certain aspect of the world and this is entirely compatible with MN; but such a concession is just an expression of appropriate scientific modesty. The possibility itself that we might not end up making headway in some area of life doesn't allow us to make assumptions one way or the other. Naturalistic intractability is something to be established empirically.

We may, therefore, study the language faculty as part of a properly naturalistic approach to both language as well as part of the structure of the mind (Chomsky 1980/2005, chapter 1). There is no reason to assume that any aspect of the mind is *a priori* intractable to scientific investigation, or that scientific inquiry will not uncover any sort of interesting and fruitful structural characteristics within that domain. Any declaration that the mind is just not penetrable by scientific investigation should be driven by data. When Davidson, however, makes the claim that we can never 'expect … to be able to explain and predict human behaviour with the kind of precision that is possible in principle for physical phenomena' (Davidson 1974/80, 230), he goes beyond a claim about the differences for the terms of respective scientific fields, and makes a principled claim about what can and cannot be achieved by inquiry.

As Chomsky emphasises, we cannot merely assume that no interesting structure is to be found in the mind, or that some aspect of mental phenomena is not worth studying, because no other as-yet-unexplored system, function or organ in the body would be approached with such an attitude:

> no embryologist would be much interested in the proposal that unstructured systems with unknown properties might some day account for development of organisms without appeal to intricate theories involving concentration of chemicals, the cell's internal program, production of proteins and so on
> (Chomsky 1993, 33-4).

In a similar line of thought to Davidson, Strawson makes the stipulation that:

> no one can suppose that tracing the physical causal route through the physical organism … would in fact yield a causal explanation of human *action*, of human *behavior*. Any explanatory account of a person's behavior … belongs firmly to the personal story, the biographer's or diarist's story … [consisting of] mental events and states
> (Strawson 1985, 63).

Once again, a prediction is made about the degree of precision we will achieve in future inquiry. Investigation may eventually supply data that supports Strawson's claim, but to make such a stipulation in advance is to commit to a strongly methodologically dualist assertion.

2.3.4. Criterion Four: against common sense and metaphysics

MN requires no commitment to common-sense notions, or common-sense stipulations (Chomsky 1993, 32-3); (Chomsky 2000, 37). As already explained, classical physics broke down any remaining correlation between our common sense notions and scientific explanation. Similarly, scientific inquiry is not bound to honour pre-investigative metaphysics: the terms of scientific discourse carry no metaphysical implications. Were science to progress by adhering to common-sense ideas, or by preserving metaphysical claims, then scientific understanding would no longer be leading the way. Prior assumption would determine inquiry and this stands in conflict with the basic tenets of MN.[27]

We need only treat terms such as "mind" or "mental" as we would other terms which might specify a broad domain of inquiry, that is, 'without metaphysical

[27] There are times when meta-theoretical ideas directly inform hypotheses or theories, but such cases are still motivated by inquiry, and not arm-chair stipulations or everyday understanding. Cf.: chapter 3.

import and with no suggestion that it would make any sense to try to identify the true criterion or mark of the mental' (Chomsky 2000, 75). We are not permitted to give "mind" a metaphysically distinct status any more than we are for other biological systems such as "the respiratory system". Take the examples of chemistry or electronics: '[c]ertain phenomena, events, processes, and states are called "chemical" (etc.), but no metaphysical divide is suggested by that usage' (ibid., 75); c.f.: (Chomsky 1991a). The mind, then, should be treated in the same way as would any other theoretical concept, in the beginning stages of a line of inquiry; a phenomenon is to be conceptually categorised under a useful but metaphysically innocuous term.

We are in no way committed to retain our folk theories or every-day terms and notions when undertaking scientific inquiry.[28] There might end up being a rough correspondence between the scientific and common-sense concept, but if so, this is (scientifically) uninteresting (Chomsky 2000, 22-3). The terms and constructs of any theory or hypothesis are led by the requirements of investigation and then the subsequent discoveries. In other words, science is not answerable to folk notions, or the everyday categories of phenomenal experience. No physicist would be guided by the notions of "object" or "hardness", or by our folksy distinctions between "moving" and "stationary" (ibid., 20-1 and 88-9).

The present point draws out further methodologically dualist tendencies within physicalist approaches to the mind. Whilst Papineau acknowledges that the terminology of physics is independent from categories at other levels of description of the natural world (Papineau 1993, 13 and 31-2), he defines the domain of physics on the basis of those phenomena which appear solid to us; he asserts that from a 'pre-theoretically given class of paradigmatically physical effects, such as stones falling, the matter in our arms moving, and so on ... we can effectively characterize the rest of physics' (ibid., 30).[29] Physics is defined as a set of theories which

[28] The study of folk psychology may be approached as the topic of naturalistic study but such an approach is quite different from allowing folk notions to *inform* the course of a separate inquiry (Chomsky 2000, 135). Collins (2007) provides a useful discussion of the extent to which folk notions become redundant in the face of scientific terms.

[29] Davidson's naturalistic approach proceeds by 'accepting the deliverances of science and common sense,' on the basis that 'naturalism starts by accepting common sense (or science) and then goes on to ask for a description of the nature and origins of such knowledge' (Davidson 1995, 5); c.f.: (Papineau 1993, 2-3).

provides explanation for types of phenomena to which physics itself makes no reference, wherein Papineau even makes explicit the absence of such types from the concerns of physics. It is unclear how categories from outside physics help us establish any notion of physics, and such a definition clearly violates the present criterion of MN.

Note, however, that a distinction may be made between a guiding regulative notion of unity (as a minimally metaphysical claim) and the fixing of terms by metaphysical connotations. The unity in question is regulative rather than constitutive, and so there is no occurrence of a theoretical term being metaphysically loaded.[30] Instead, the regulative notion is a principle by which scientists themselves work.

2.3.5. Criterion five: ongoing development of terms

A positive thesis follows from the previous criterion: just as scientific terms should not conform to assertions of common-sense of metaphysics, terms should also be free to develop through the course of inquiry. Scientific terms and categories do develop, and therefore should be permitted to develop (according to empirical investigation and results), without being fixed to their initial meanings. Concepts may develop both within a given theory, and across theory-change. Prior to any inquiry, terms must be posited at some degree of abstraction because too little is understood about the phenomenon within a new scientific field.

Consider the various optical theories from the 18th to the 20th centuries; light was initially thought to consist of particles, but then this idea was replaced by Fresnel’s wave theory (in which the luminiferous aether was posited as the medium through which the waves travelled). Both the wave theory and the theoretical construct of the aether were subsequently dropped, as optics developed further still. Whilst the term “light” is taken to have some degree of continuity across the changes (after all, it is not that an entirely new concept is introduced for a new theory), the

[30] C.f.: chapters 3 and 4. In chapter 4, I shall spell out the detail of such a regulative unity.

definition of light is distinct for each given stage of explanation, and is not bound by the previous conceptions (Worrall 1989, 107-8).

We may, therefore, start out in the study of mind just as other sciences started out: by identifying abstract concepts, prior to any knowledge of the particular mechanical or biological realisations of these abstractions. Consequently, the positing of abstract architecture, or of concepts of cognitive science and linguistics, is perfectly legitimate:

> When we speak of the mind, we are speaking at some level of abstraction of yet-unknown physical mechanisms of the brain, much as those who spoke of the valence of oxygen or the benzene ring were speaking at some level of abstraction about physical mechanisms, then unknown.
> (Chomsky 1988a, 7).[31]

Returning to the dissolution of the mind-body distinction, any persistent use of some supposedly well established or clear notion of "solid matter" constitutes a refusal to respect the development of scientific terms.[32] In a similar way, assumptions to the effect that we have already completed or exhausted the full set of physical scientific explanations also stand in direct contradiction with the allowance for scientific terms (and indeed theories) to progress. Lewis, for instance, describes materialism as 'metaphysics built to endorse the truth and descriptive completeness of physics *more or less as we know it* [my italics]' (Lewis 1986, *x*). He also asserts 'that there is some unified body of scientific theories, of the sort we now accept, which together provide a true and exhaustive account of all physical phenomena' (Lewis 1966/88, 105).

---

[31] For further justification of the inquiry into the language faculty, starting at an abstract level, see for instance: (Chomsky 1988a, 7-8; 1991a, 5; 1991b).

[32] For instance, Kim takes substance dualism to have been replaced with a mereological picture of the physical world, in which the universe, at a fundamental level, is 'thought to consist of … the basic bits of matter out of which all material things are composed' (Kim 1998, 15). The supposition that this accurately represents anything based in physics goes unchallenged (Ladyman and Ross 2007, 18), and yet Kim's 'micro-parts of the object' (Kim 1998, 84) still sound too close to Cartesian or common-sense notions of "solid matter", already shown to be untenable. In a similar way, Quine describes natural science as the concern for 'devising theories … in light of physical impacts on our physical surfaces' (Quine 1992, 9). On a generous interpretation, "impacts" and "surfaces" may be involved in certain areas of physics, but the terms hardly represent the concerns of such domains (Ladyman and Ross 2007, 4-5). Although in places, Quine readily acknowledges that the theoretical constructions of science are far more subtle (Quine 1951/64, 44-5), he does so whilst asserting that 'science is a continuation of common sense' (ibid., 45).

2.3.6. Criterion six: science should determine methodological variations

There is no requirement that the various sciences should use the same methodology, but any methodological variation should (according to MN) be determined by inquiry and not stipulations at the outset (Collins 2010, 45). In other words, we must start from the same set of any common preliminary assumptions which hold in the beginnings of investigation, for other fields. If scientific inquiry approaches a new domain for investigation, and certain very general methodological starting points hold in the other sciences, then the simplest hypothesis at the outset would be to assume the same assumptions until inquiry itself demands methodological specialisation. Such preliminary methodological assumptions need only be very basic; for instance, the fruitfulness of scientific investigation should not be assumed (as explained in §2.3.3).

The requirement is, once again, that we 'the attempt to study … [the mind] as we do anything else in the natural world' (Chomsky 2000, 134) so that the mind is to be given no special treatment, *a priori*, just because it is the mind,[33] a point which Chomsky frequently emphasises in his defence of a naturalistic approach to language:

> Is there some body of evidence, established through scientific inquiry, or observation, or introspection, that leads us to regard mental and physical development in such different ways? Surely the answer is that there is not. Science offers no reason to "accept the common maxim that there is nothing in the intellect which was not first in the senses," or to question the denial of this maxim in rationalist philosophy.
> (Chomsky 1975, 11).[34]

Where every other human system has turned out to be structured in a complex way, worthy of scientific investigation, we have no reason to suppose

[33] For further justification of the inclusion of the study of language as part of the domain of natural inquiry, see: (Chomsky 1959; 1975, especially chapters 1-2; 1980/2005; 1986, especially chapters 1-3; 2000, especially chapters 1, 4 and 5).
[34] Chomsky is quoting Arnauld (1964, 38).

(ahead of inquiry) that the mind should be any different.[35] Biological structures do not develop from experience, and science proceeds under this assumption (Chomsky 1975, 9-11). The growth of some cognitive linguistic competence may, therefore, be thought of 'as analogous to the development of a bodily organ' (ibid., 11), in light of what has been discovered about the uniformity of development; c.f.: (Chomsky 1993, 29). [36] If the mind turns out to be structurally uninteresting, then so be it; but this should be established empirically, through the process of investigation.

Familiarity with a given phenomenon can prevent us from being alert to the potential for discovery of further interesting and more complex structures or properties (Chomsky 1968/72, 24-6).[37] We are familiar with language, for instance, as we utilise it on a daily basis; this familiarity may potentially persuade us that we have privileged access to the workings of that phenomenon, and that the interesting structures are all readily available on the surface level. But compare linguistic abilities to other basic capacities, such as identifying the colour red, manoeuvring around objects when walking, and so on. All of these capabilities come easily and automatically to almost all of us (pathologies aside). The activity appears simple enough on an experiential level, but it is uncontentious to point out that such familiarity does not grant automatic knowledge of all the systemic workings by which the action is made possible. Our knowledge-as-ability is entirely divorced from explanations of the underlying biological processes.

The structural complexities of language should, likewise, not be overlooked (for instance, because of our familiarity with producing linguistic behaviour). Consider the difference between a five-year-old child's ability to construct a sentence, and a linguist's knowledge of the syntactical structure and rules governing

---

[35] Examples of the consideration of internal structure may already be found within certain approaches to the mind, such as those in medicine. For instance, psychologists and psychiatrists consider behaviour as a part of the full data set, when addressing mental illness, but they nonetheless take seriously the potential internal aspects involved (for instance, chemical or biological factors, or explanations from intentional psychology); where symptoms are indicated by the behaviour of an individual, mental illness is still studied scientifically without any restrictive assumption that no value is to be found via investigation of internal structures.
[36] Chomsky points out that, if we are to keep in line with a comparison to the maturation of other biological systems, it makes more sense to describe language growth as opposed to language learning, when considering language acquisition (Chomsky 1980/2005, 134-5).
[37] Mistaking familiarity for access to data often seems to motivate claims about the special status or quality of first-person consciousness. C.f.: (Nagel 1974).

a sentence-form of that type (Chomsky 2000, 54); (Collins 2010, 90).[38] The five year old doesn't consciously apply those rules, or think about parsing, embedded clauses or scope, and so on, but the child is still perfectly capable of utilising their linguistic capacity.[39] Much available data substantiates the idea that the structure of language is far more complex than its surface form (Chomsky 1968/72, 37; 2000, 28).[40] Extensive data also supports the idea that our development of linguistic capacities could not be achieved on the sole basis of experiential input or tutelage, which in turn leaves no use for behaviourist approaches.[41]

Assuming that there is no interesting systematic structure to the mind constitutes an *a priori* stipulation that mental phenomena are to be approached differently, from the outset. Any stipulation of this sort therefore advances a methodologically dualist approach to the mind. Behaviourism involves such a 'faith in the shallowness of explanations' (Chomsky 1968/72, 25), because external data are approached as though surface descriptions constitute the most significant (or only) area of interest.

Quine endorses the idea that '[e]ach of us learns his language by observing other people's verbal behavior … depend[ing] strictly on overt behavior in observable situations' (Quine 1990, 38) and consequently, his co-called naturalism towards language and mind not only disregards information directly from inquiry, but stipulates an *a priori* methodological difference for these domains. Quine's behaviourist naturalism turns out to be a 'behaviorist psychology of no known scientific interest' (Chomsky 2000, 80), and one which 'represents a sharp and unwarranted departure from the natural sciences' (Chomsky 1993, 32); c.f.: (Chomsky 1988b, 414; 2000, 95).

[38] C.f.: (Chomsky 1975, 10).
[39] The five year old is able to use features of language, and linguistic constructions, which they have most likely never encountered in experience (Chomsky 1988b, 410), and the complexity of which far exceeds their respective capacity for logical reasoning (ibid., 414-5).
[40] Chomsky provides extensive evidence for, and detail about, the structure of language. See for example: (Chomsky 1957; 1965; 1971; 1975; 1980/2005; 1988a; 1991b; 2002).
[41] For an extensive critical discussion of behaviourism, see: (Chomsky 1959). For an elucidation of Chomsky's explicitly non-behaviourist linguistics, see: (Collins 2008, especially chapter 2).

In accordance with the defence of the six criteria above, I conclude that methodological naturalism is the appropriate naturalistic position to adopt. Having defended methodological naturalism, from here on, I will just refer to this notion as "naturalism".

2.4. Kant's transcendental idealism and cognition

2.4.1. Kant's interest in scientific inquiry

My focus is on Kant's ideas insofar as they can be naturalised. I am therefore interested in a characterisation of Kant's philosophical aim as an investigation into the conditions for the possibility of scientific inquiry, in the *CPR* as well as in other works (Kant 1783/2001; 1786/2002). I shall defend this reading in the present section, before moving on to explore how it might be made consistent with naturalism. My chosen approach should be understood in distinction from other readings which focus on Kant's epistemology or metaphysics, even where such readings are given a naturalistic flavour. Put otherwise, my concern is primarily with Kant's philosophy of science, and not with realist concerns about scepticism, or the preservation of Kant's overall system of metaphysics and epistemology as a whole.[42]

Kant viewed Newton's physical theories as paradigmatic of the type of rational and cohesive thought of which humans are capable (Friedman 2001, 11). Kant's goal can be understood as the elucidation of the set of conditions for scientific inquiry, by means of explaining those conditions of experience which make inquiry possible to begin with.[43] At Kant's time of writing, the gap between scientific

---

[42] Whilst standard realism (c.f.: Putnam 1978/2010; 1987) may or may not overlap with naturalistic concerns, my primary commitment is to naturalism and not epistemology or metaphysics. Readings of Kant which attempt to tackle realist issues regarding (for instance) the defeat of scepticism are not my concern. This is not to say that alternative readings are not useful in other respects. For instance, Hanna (2006) develops a specifically anthropocentric Kantian approach to the sciences, as a sort of Kantian empirical realism (ibid., 44) which nonetheless encompasses all aspects of Kant's critical system. Elsewhere, Hanna (2001) develops a specifically updated yet Kantian approach to objective judgement and cognitive semantics, with relation to issues in analytic philosophy; c.f.: (ibid., 119).

[43] Kant's interest in Newton's work may also be identified in his other work (1783/2001; 1786/2002; 1936/93). For more on Newton's explicit influence on Kant's overall investigations, see: (Friedman 1992, especially chapters 3 and 4; 2003; 2006). Friedman asserts that 'there can be no doubt that ... [Newton's] work is paradigmatic for Kant' (Friedman 1992, 136). Cassirer (1918/81) also emphasises

explanation, and our phenomenal experience of the world, was widening drastically.[44] Even so, the geometry upon which Newton's laws of physics were based (*viz*., Euclidean geometry) was the same geometry which describes phenomenal experience. Just enough continuity remained, therefore, between the mathematical basis of scientific explanation, and the geometry of our experience, for Kant to justifiably explore the conditions of our experience as a means of the groundwork for our conditions of inquiry.[45]

Newton's work raised questions for Kant, as to how mathematics could be applied lawfully to the natural contingent world with such accuracy and success. Kant saw that the mathematical laws of physics, based upon the framework of the necessity of geometry, are applied with necessity and uniformity, and so he questioned how the contingency of the phenomenal world of experience appeared as though it was nonetheless lawfully governed.

The deep insight of Kant's Copernican Turn is that we do not passively receive the world and fortuitously happen to arrive at the correct understanding of it. It is the very nature of our cognition which provides the constitutive principles that allow the world to "fit" to our minds, and which makes possible experience, knowledge and, therefore, objective inquiry. In other words:

> [it is] Kant's great discovery that the object of knowledge is not immediately given but constructed, and that it contains conceptual elements not contained in pure perception. Such a construction is not a mere fiction; if it were, its structure could not be so strictly prescribed from outside by repeated perceptions.
>
> (Reichenbach 1965, 49-50).

In order that physics provides an objective and uniform explanation of the natural world, the modality of the laws of physics requires some ingredient not given by

---

the significance of physics in Kant's work; for Kant (for instance), the concept of matter is ultimately derived from our understanding of forces, which in turn depends upon the concepts of the understanding (Cassirer 1918/81, 222).

[44] As Friedman usefully puts it, with the developments in Newton's work, the 'unproblematic fit between physical theory and sensory experience [was] irretrievably lost' (Friedman 2001, 75).

[45] Kant's notion of space, however, was not identical to Newton's. Even so, Kant still takes Newton to have 'determined the true motions in the solar system by showing us how actually to construct the privileged frame of reference [of space] in question' (Friedman 2003, 32).

experience, precisely because the world of experience is contingent and not necessary. This ingredient is given in the aspects of cognition as the *a priori* constitutive conditions that make possible any objectivity of experience or inquiry.

Kant defines 'the real problem of pure reason' as an attempt to answer 'the question: **How are synthetic judgements *a priori* possible?**' (*CPR*, B19), explaining that:

> [i]n the solution of the above problem there is at the same time contained the possibility of the pure use of reason in the grounding and execution of all sciences ... i.e., the answer to the questions: **How is pure mathematics possible? How is pure natural science possible?**
> (ibid., B20).

Given that '[g]eometry is a science that determines the properties of space synthetically and yet *a priori*', Kant asks what 'the representation of space [must] be for such a cognition of … [geometry] to be possible' (ibid., B40). The forms of intuition are taken to ground the objectivity of experience, and are therefore constitutive of the very objects of scientific inquiry.[46]

2.4.2. The conditions for inquiry

The faculties of sensibility and understanding actively supply the conditions (i.e., the forms of intuition and the concepts) for the possibility of experiencing empirical phenomena. For instance, the necessity in the laws of physics is given via the necessity of geometry being grounded in the intuitive form of space.[47] The sensibility is our 'capacity (receptivity) to acquire representations through the way in which we are affected by objects' (*CPR*, A19), and similarly, the concepts of the understanding 'supply the objective ground of the possibility of experience [and] are necessary just for that reason' (ibid., A94/B126). The forms of intuition themselves do not directly provide us with meaningful judgements on their own (say, about space or time), until combined with the categories of the understanding and that

[46] Cassirer emphasised the point that '[t]he question of the possibility of applying exact mathematical concepts to the appearances of nature … had continually engrossed … Kant' (Cassirer 1918/81, 177).
[47] For a discussion of precisely how the form of space is supposed to provide us with geometry, and of how to understand Kant's philosophy of mathematics and geometry *per se*, see: (Friedman 1992, chapters 1 and 2); c.f.: (Torretti 1999, 113-120).

which is given through experience. As Kant explains, '[w]ithout sensibility no object would be given to us, and without understanding none would be thought' (ibid., A51/B75).

We can take the term "transcendental" to apply to those aspects of cognition which are 'occupied not so much with objects but rather with *a priori* concepts of objects in general' (ibid., A11). In other words, the transcendental components of cognition are those which provide some ingredient that has no empirical basis, thereby supplying the necessity by which phenomena are constituted, such that inquiry into those phenomena may be objective and may allow us to generate lawful (and not contingent) generalisations.

The example of the intuitive form of space illustrates the way in which Kant establishes the conditions for inquiry.[48] Spatiality is not something that we can identify from looking out into the world because, to do so, we would still need a pre-existing notion of space such that we could correctly extract the salient features of our experience so as to form that very concept of space. In order for us to identify (for instance) objects *qua* entities with distinct spatial locations, measurements of extension, and so on, first of all we require a notion of space by which to detect the relevant features that we would supposedly use in order to develop the concept of spatiality. Any data retrieved from experience, through which we would have to acquire spatiality, necessitates some preconceived notion of space. Therefore, it would not be possible for us to have obtained our understanding of space from an empirical experience of the world without having that very notion of spatiality to begin with; Kant concludes from this that space 'is a necessary representation, *a priori*' (*CPR*, A24/B38).

---

[48] The concepts of the understanding could just as easily provide an example of Kant's transcendental system, whereby it is precisely some *a priori* component which makes possible the cognition of objective judgements about the natural world. For a very thorough and informative account of how this works, see: (Hanna 2001, chapter 2); c.f.: (Cassirer 1918/81). Cassirer also notes that 'it is shown in the *Critique of Pure Reason* and in the *Metaphysical Foundations of Natural Science*, which is an appendix to the former, that the ... general laws of the understanding correspond to and underlie the three basic laws laid down by Newton' (ibid., 291).

2.4.3. The "Kantian Question"

So far, I have not evaluated or defended the success of Kant's proposed conditions for inquiry. But even if Kant is not successful, we may reject Kant's conclusion, whilst his general investigative question remains (Reichenbach 1965, 74). What we can retain, therefore, is precisely Kant's general approach towards Newtonian physics, and his question about the conditions of its possibility and the constitutive principles upon which the scientific theory is developed. The overarching investigative approach can be updated such that the general Kantian project (so construed) is retained. I shall call this the Kantian Question (KQ). Let the KQ be defined in the following manner:

> What conditions are there, such that scientific investigation is made possible? Put otherwise, what are the conditions for the possibility of scientific explanation or theorisation?

This should be understood as the specifically scientific vein of Kant's interest, and is tailored to that understanding. The KQ, therefore, can be understood as a modification of the Kantian project, so as to specifically capture Kant's interest in scientific inquiry and philosophy of science.[49] Although such a reading does not stick to the full metaphysical project in the *CPR*, I shall justify why I believe that the very modification of Kant's inquiring question may actually be taken as entirely consistent with the spirit of Kant's critical philosophy.

Kant describes the *CPR* as a work which constitutes part of the ongoing development and progression of human thought and understanding (viewed in its broadest sense), rather than as a dogmatic or complete set of answers; in other words, his aim is an 'investigation, which we can properly call not doctrine but only transcendental critique, since it does not aim at amplification of the cognitions themselves but only at their correction' (*CPR*, A12/B26); c.f.: (Cassirer 1918/81, 144). His intention is to indicate the way forward and 'point out what must be done' rather than to provide any completed system or metaphysics (Kant 1783/2001, 274).

[49] I do not wish to suggest that this is a thoroughgoing reading of Kant; nor is it the only way in which to consider Kant's work in the light of contemporary philosophy of science.

Kant also draws attention to the fact that inquiry will inevitably progress, despite any potential resistance or objections (ibid., 257), and he additionally emphasises his wariness of dogmatism (ibid., 274). Such acknowledgement indicates Kant's awareness of, and respect for, the mode of advancement of human inquiry, as something for which one's ideas might offer an important contribution, at a certain stage, but only ever in a relative sense; inquiry will inevitably move on and it is, therefore, only fitting that the ideas which once proved useful should ultimately be discarded.

According to such aspects of Kant's approach, it is entirely within the spirit of Kant's critical philosophy for his ideas to constitute an aspect of just one particular stage of human understanding, and to be adapted accordingly as we make further progress still. In other words, the modification of Kant's aims and ideas may be seen itself as entirely compatible with the Kantian spirit of inquiry. Cassirer points out, in fact, that were we to reject and move beyond Kant's philosophy completely, this would be in keeping with Kant's approach, given that his intention 'was not to ground philosophical knowledge once and for all in a fixed dogmatic system of concepts, but to open up for it the "continuous development of a science" in which there can only be relative, not absolute, stopping points' (Cassirer 1921/2003, 355), in accord with to Kant's very characterisation of the completion of science as a regulative rather than a constitutive boundary. Kant himself argues, towards the end of the *CPR* that '[t]he consciousness of my ignorance ... should not end my inquiries, but is rather the proper cause to arouse them' (*CPR*, A758/B786), in the context of a never-to-be-realised completion of science (which in turn acts as a guiding ideal to perpetuate further investigation).

2.4.4. Transcendentalism versus naturalism

Two aspects of Kant's transcendentalism look as though they may be in tension with naturalism, namely, the notion of a noumenal realm, and the transcendental characteristics of cognition itself. The corollary of any set of conditions is the negative notion of the unconditioned; conditions bring limits, and with the notion of a limit comes the notion of that which lies beyond. So, from the necessary conditions for our possible experience, the negative notion of the absence of those conditions must follow (i.e. the unconditioned). In chapter 4, I argue that the noumenal is a purely negative boundary notion, which regulates our sense of the limitations of the conditions for experience. It is only the phenomena of the world of experience which are suitable for naturalistic inquiry. The noumenal (by definition) does not constitute any domain at all, and is therefore not describable as either tractable or intractable to naturalistic inquiry. The noumenal boundary provides a regulative rather than stipulative limit to our capacity for experience and so for inquiry; no strict demarcations are imposed as to the precise point at which scientific investigation is no longer suitable, and so the notion of a noumenal realm is, at the very least, not inconsistent with naturalism.

The transcendental nature of cognition poses a more serious problem. I have already argued that the mind may be approached naturalistically, without any prior assumptions about mental phenomena being unsuited to scientific inquiry. On the other hand, the conditions supplied by cognition are not objects of the phenomenal realm, but are constitutive of the objects of the phenomenal world, so that an empirical inquiry into these conditions is not possible. In other words, the very same components of the mind which make possible objective inquiry are not naturalistically tractable themselves, precisely because they are transcendental and not empirical by nature. Kant’s philosophy of mind is guilty, in this respect, and by contemporary standards of inquiry, of the methodological dualism detailed in §2.3. It seems that Kant’s model of cognition requires us to impose at least some constraints on the potential for naturalistic inquiry into the mind, demarcating certain areas of cognition as being “off limits” to naturalistic inquiry, on an *a priori* basis.

2.5. The Kantian Question and thinking about science

2.5.1. Cognition and cognitive science

The first part of this chapter demonstrates that our commitment should be to a form of naturalistic philosophy which does not impose metaphysical commitments upon inquiry. We can separate the two aspects of transcendentalism: the components of cognition and the conditions for inquiry. The challenge is to establish how these two aspects are to be retained, if at all, in accordance with naturalism.

Kant's philosophy of mind turns out both to determine the possibility for naturalism, and to preclude simultaneously a naturalistic theory of mind. For this reason, transcendentalism offers a methodologically dualist approach to mental phenomena. On Kant's terms, a tension arises between cognition *qua* the source of the conditions for naturalistic inquiry, and the naturalistic approach to cognition *qua* a phenomenon suitable as an object for that same inquiry, because the cognitive system is both the means of, as well as the object for, inquiry. Cognition would thereby be required to extend beyond itself in order to explain itself, sending transcendentalism into contradiction. We can, however, consider the two elements independently (of cognition on the one hand, and conditions for inquiry on the other).

Kant's idea of looking to cognition, as the foundation for the conditions of inquiry, could be compared to contemporary ideas about abstract cognitive architecture. We might say that Kant identifies components of cognition which are functionally discrete; in other words, some aspect of cognition may be understood as performing a function or process which is independent enough so as to be considered in abstraction from other processes. For instance, in more contemporary terms, there would be an entire poverty of stimulus from which we would have to extract our notion of time, if we did not already experience the world temporally.[50]

Within cognitive science and the philosophy of mind, various suggestions have been made about the particular aspects of cognition that contribute to the specific skills utilised in scientific inquiry or theorisation. One example is the idea that analogous reasoning may be a crucial component of any potential scientific thought (Carey and Spelke 1994); (Fodor 1983, 106-7). Chomsky also offers a speculation that the human capacity for making scientific progress might be due to

[50] Unlike poverty of stimulus considerations in other areas of cognition (such as language), instead of there being very poor and inconsistent levels of the relevant data (as is the case with linguistic experience), we would have no spatial or temporal data whatsoever as we would have no means by which to recognise time and space *per se* within experience, if we did not have some previously given notion of such concepts.

some specific cognitive faculty, namely, the Science Forming Faculty (SFF), which constitutes 'the aspects of the mind … that enter into naturalistic inquiry; call them the "science forming faculty" (SFF)' (Chomsky 2000, 82-83). In other words, the 'successful natural sciences, then, fall within the intersection of the scope of SFF and the nature of the world' (ibid., 83).

The details of the above proposals are not important for now; the significant point is the notion of a naturalistic investigation into those aspects of the mind which may be relevant to scientific reasoning.[51] In light of these suggestions, we could think of a very broad set of cognitive capacities which are involved in scientific thought, inquiry or theorisation, under the heading of "Scientific Cognitive Capacities", or SCC. The SCC therefore provides a sort of nominal index to whatever set of cognitive processes, faculties or reasoning-skills, etc., are provided by the mind as conditions for the possibility of scientific inquiry (whatever these aspects of cognition turn out to be).

2.5.2. Broader conditions for inquiry

Certainly, human cognition plays a central and necessary part of scientific inquiry, but it does not constitute the entirety of the conditions required for scientific investigation and progress. Neither does the entire set of human cognitive capacities enter into the conditions for inquiry. For a start, scientific research is conducted as a group activity, whereby different individuals bring different intellectual skills to the research. In that respect, the collective cognitive capabilities (even for just one specified field of science) are broader than the set of skills held by any one scientist, whatever their area of expertise.

The various relevant cognitive capacities are not all of the type of species-wide or uniform biological endowments of the human mind; they are not possessed by every human by virtue of their having a mind (in contrast with, say, our capacity for processing the world in three dimensions), and such cognitive skills do not develop in the same way as other universal biological endowments. Outstanding or

[51] I discuss the SFF at greater length in Chapter 5.

unique capacities are not found in every human; crucial knowledge, techniques and scientific reasoning-skills are developed over time, with deliberate effort, specific training and intensive learning. For someone to become a successful scientist, certain cognitive propensities must be present (perhaps capacities which are variously species-wide or specialised), but then the necessary training, practice and honing of those skills must take place.

Factors beyond intellectual skill are also significant; technological developments enable specific measurement techniques and means of collecting otherwise unavailable data, which in turn determine the extent and accuracy of experiments, the types of hypotheses formulated, and so on. “Science”, as an institution or a practice, is also qualitatively distinct the type of phenomena that fall under the category of “suitable phenomena for inquiry”. Some sub-sections of the scientific institutions or practices might be studied naturalistically in some way; we can identify certain trends in human behaviour or social institutions, which are in turn suitable for naturalistic inquiry of some sort. For instance, one might inquire into the sociology of institutional scientific research; one might even try to find some regularity in the movements of scientists in a lab (although this would no doubt be an entirely uninteresting study). But science is not some phenomena which can be isolated to a reasonable degree, so that hypotheses may be made, data collected and explanatory generalisations formed.[52] We have not uncovered the practice or institution of science, so to speak, as though it was “out there”, ready for us to find; it is something we have actively sought and established. Put another way, we have not developed the category “science” (whether understood as an activity or practice, an institution, a body of information, etc.) as a way of carving up the phenomena we find in the natural world.

The institution of science is something which develops and changes over time; it does not rely solely on some universally fixed mental architecture for the constitutive conditions for theory-development, but relies upon the collective skills and actions of humans, meaning that the cumulative effect bridges individual

[52] I am making a distinction, here, between the various data sets *generated* by scientific enterprise, and some notion of a set of data gathered *about* “science” *per se*. The possibility of studying certain specified aspects of science is quite different from taking the category “scientific activity” as a focus for inquiry, as we do for (say) the category “tectonic activity”.

psychology as well as geographical and generational distance. Let such conditions be referred to as "mind independent"; whilst they rest upon human minds for their instantiation, this set of constitutive conditions extends beyond that which is endowed to each human mind.[53] The conditions for scientific inquiry or theorisation, in other words, are not given to each human by virtue of their having a mind, but actually far exceed the abilities of the individual (and, indeed, certain conditions even exceed those skills of *groups* of individuals). We can, therefore, think about the conditions for the possibility for scientific inquiry in much broader terms than the set or sub-set of cognitive capabilities.

At this stage, the conditions for scientific inquiry are still very loosely defined. We can, nonetheless, conceive of meta-scientific investigation into whatever it is that allows for the possibility of objective inquiry. In other words, the question remains as to how it is that humans are able to find lawful generalisations about a contingent world, which nonetheless hold with regularity and uniformity. On a broad construal of transcendentalism, taken from the KQ, we can think of transcendental conditions as those which are necessary for inquiry and thereby develop a naturalised "transcendental" question which is compatible with a commitment to naturalism. By understanding these conditions in a broader way, the universal aspects of human cognition need no longer be thought of as transcendental themselves, and cognition may be returned to the domain of natural phenomena, without any metaphysical baggage.

The SCC does not constitute the entire set of conditions which make scientific inquiry possible. The conditions may well largely depend upon human thought in the broadest sense. What this means, however, is that human cognition may be investigated in terms of the specific skills required in order to undertake scientific thought. But if we acknowledge the much broader set of conditions for the possibility of science, then a naturalistic study of the mind no longer entails the use of some system (i.e., human cognition) in order to investigate that same system. The species-wide characteristics of cognition may be studied naturalistically, if we do not take cognition *per se* to supply the full or fixed set of conditions for inquiry. At the

[53] From here onwards, I shall take "mind-independence" to refer to such a notion, as construed in the way set out here. C.f.: chapter 3, §3.3.2 and §3.5; chapter 4, §4.5.2; chapter 5, §5.5.8 and §5.6.

same time, we are free to embark on a meta-scientific examination of the broader set of conditions which make possible scientific inquiry; in neither examination do we end up in the sort of reflexivity or tension described above.

Various questions remain unanswered at this stage: a closer examination of Kant's original conditions for inquiry is required in order to spell out exactly how this broader construal of "conditions" retains a distinctly Kantian character. At the very least, Kant supplies an articulation of the question about what conditions there must be for the possibility of objective inquiry. In other words, Kant's problem is still our problem.

2.6. Conclusion

In order to utilise those aspects of Kant's philosophy relevant to a naturalistic approach to the mind, the development of a revised or "quasi-Kantian" naturalism is required, as opposed to a thoroughgoing commitment to Kant's philosophy of cognition to the letter. This Revised Kantian Naturalism (RKN) entails an adaption of Kant's ideas, whereby the very process of revision itself upholds the spirit of Kant's attitude to his critical philosophy. RKN, however, must be spelled out and defended in order to show how it is both Kantian and naturalistic, and in order to substantiate the notion of the "conditions" for inquiry. The brief discussion of the conditions for inquiry, given in the present chapter, indicates the emergence of a set of mind-independent conditions; such a notion will be developed within chapter 3. In chapters 3 and 4, I shall argue in detail for the full character of RKN; in chapters 5 and 6, I show how RKN can be put to valuable use.

Chapter Three:
In Defence of Revised Kantian Naturalism

3.1. Introduction

In the previous chapter I spelt out the possibility of a Revised Kantian Naturalism (RKN), under a reading of the *CPR* which focuses on the updated Kantian Question (KQ). I argued that, for RKN, the conditions for scientific inquiry must be such that they allow for a naturalistic inquiry into the mind. In the present chapter, I shall defend RKN, the details of which are derived from Cassirer's (1921/2003) notion of constitutive but dynamical principles, which in turn are grounded within the overarching notion of a regulative *a priori* principle regarding the unity of science.[54] I shall start by outlining the difficulty for Kant's ideas, in light of specific changes in geometry since Newton's physics; I shall subsequently defend RKN, with reference to both classical physics and the special theory of relativity (SR), demonstrating the way in which Cassirer's regulative principle of unity is a crucial part of RKN.[55]

3.2. Space and geometry

3.2.1. The form of space

The claim that Kant's ideas are affected by the advances in physics and geometry is not contentious, and it is common to find remarks to the effect that 'the development of non-Euclidean geometry and its application in physics were, historically, the main

[54] As well as drawing on Cassirer's ideas, I also follow the arguments of Friedman (2001). Friedman (ibid.) articulates a picture of scientific rationality in which "relativized *a priori*" principles are taken in combination with the regulative ideal of unified science, in which he draws significantly upon Cassirer's work.
[55] Constitutive principles are equally identifiable in the general theory, although it will suffice to use the special theory to illustrate my argument.

reasons why Kant's theory of geometry and space came to be rejected' (Parsons 1992, 75).[56] I shall use a discussion of Kant's argument for the form of space as a means of demonstrating the relevant overall difficulties with Kant's proposed *a priori* components of cognition, *qua* principles for the conditions of inquiry.[57] In §3.2, I shall argue that Kant's *a priori* form of space no longer provides the conditions for constitutive principles for the possibility of inquiry, because such principles cannot be fixed and therefore look as though they cannot be grounded in cognition; subsequently, the same point also holds for Kant's other *a priori* components of cognition.

Given the KQ, I am interested in the constitutive conditions for experience insofar as they supply the conditions for the possibility of inquiry. Geometry was taken to be necessary in Kant's time, given that it was the *only* geometry available. Kant's arguments are supplied from the context of an assumption that the principles of Euclidean geometry are fixed and necessary, and therefore the arguments are taken to supply a means of explaining how geometry itself is necessary.[58] Kant frames his argument in the B edition as an answer to the question about how our cognition must be in order for us to make these synthetic yet *a priori* judgements, about this necessary geometry? (*CPR*, B40-1). It is the form of space, for Kant, which establishes the *a priori* certain truth of geometry. In other words, the forms of

[56] Further similar remarks include Strawson's description of the intuition as 'that which introduces us ineluctably and immediately to the doctrinal fantasies of transcendental idealism' (Strawson 1966, 51). Van Cleve points out that 'geometry is generally thought to be synthetic (given the rise of non-Euclidean geometries in the nineteenth century and their subsequent incorporation into physical theory in the twentieth) not *a priori*' (Van Cleve 1999, 22). Furthermore, Kemp Smith also notes that '[Kant's] statements run counter ... to the recognised methods of the mathematical sciences' (Kemp Smith 1918/2003, 40), and that geometrical principles 'cannot be proved by any mere appeal to intuition' (ibid., 41). Similarly, the space-time of special relativity, based on non-Euclidean geometry, directly contradicts Kant's notion of time (Reichenbach 1965, 2). C.f.: (Friedman 1992, 55).

[57] Space perhaps has a more direct association with the principles of the exact sciences; as Friedman explains, 'Kant does not in fact say that arithmetic stands to time as geometry does to space' (Friedman 1992, 105). Kant's specific arguments for time are comparable to those given for space, although differences obtain. Kant explains that 'space is nothing other than the form of all appearances of outer sense' (*CPR*, A26/B42) and that time is given as 'the form of inner sense' (ibid., A33/B49). Consequently, although the respective arguments run in a largely equivalent way, we can abstract away from all representations of outer objects and retain our necessarily temporal and internal sense of self, but we cannot abstract away from time and be left with any representation of inner or outer sense whatsoever. Differences aside, both time and space are necessarily forms of intuition and not concepts, and their principles are necessary and have 'apodictic certainty' (ibid., A31/B47); just as with space, time is *a priori* and cannot be 'an empirical concept that is somehow drawn from an experience' (ibid., A30/B46), and likewise, time is also given as an infinite, unlimited magnitude.

[58] Precisely how the principles of geometry are to be derived from the form of space is a separate issue. For an informative discussion, see: (Friedman 1992, chapters 1 and 2).

intuition provide the constitutive *a priori* conditions for the principles for scientific inquiry.

The principles of Euclidean geometry are not premises for Kant's argument, but are rather explained by the argument, so that Kant's transcendental 'explanation alone makes the possibility of geometry as a synthetic *a priori* cognition comprehensible' (ibid., B41). If geometry is not as Kant thinks it is, the argument is not refuted; rather, it merely fails to ground the necessity of geometry, and subsequently, to ground the conditions for the principles of inquiry within the forms of intuition.

Kant's argument for the necessary *a priori* form of space may be given as a *reductio ad absurdum* argument. Let us suppose that our understanding of the concept of space is acquired from experience; our sensory input or awareness must therefore allow us to read off perceptual information, from which we extrapolate to the general notion of space. But in order for us to identify the particular features of experience, *qua* the relevant data, we must necessarily already have some means of recognising specifically spatial properties (for instance, we would need to be able to discern locations, recognise lengths *qua* spatial dimensions, and so on). In order to learn the notion of space, we must already be in possession of spatial awareness. On reaching such a contradiction, we are forced to reject the initial assumption that space can be derived from experience, and conclude that we have the *a priori* notion of space.[59] In other words, 'the representation of space cannot be obtained from the relations of outer appearance through experience, but this outer experience is itself first possible only through this representation' (*CPR*, B38).

---

[59] Kant's argument for the *a priori* form of space is comparable with "poverty of stimulus" considerations in cognitive psychology. The issue of nativism (i.e., the thesis that some structure or function of the mind is in place prior to experience) is very complex, but work is done to establish the extent to which biological endowments or innate cognitive structures contribute towards capacities such as visual processing (Scholl 2005) or spatial reasoning (Shusterman and Spelke 2005). That a capacity, concept or functional process appears to be innate is often coupled with the fact that the relevant stimuli provide an insufficient data set from which to develop or infer the given type of concept or capacity. For example, the language faculty is thought to be innate, although Chomsky (for instance) does not argue for its innateness on the basis of a poverty-of-stimulus *argument*. See: (Chomsky 1975, 13; 1991b, 34); c.f.: (Collins 2004, 517). In the case of language, our significantly more complex internal system of linguistic structure goes far beyond our experiential "notion of language" or our "linguistic awareness", such that experience hugely underdetermines the linguistic rules we acquire and apply (Chomsky 1975, 10 and 13; 1980/2005, chapter 1; 1988b, 410). At the same time, however, our development of the language faculty requires a limited degree of experiential input (Chomsky 1975, 16; 2000, 4-5 and 8).

Kant also argues for further particular characteristics of space, in addition to the idea that space itself must be ‘a necessary representation, *a priori*’ (*CPR*, A24/B38). Space is also represented as ‘an infinite **given** magnitude’ (ibid., A23-5/B38-40) so that we have a notion of space as a singular totality (rather than of many spaces, plural). It is upon the basis of the “given magnitude” of space that Kant argues for the non-conceptual character of space; in other words, space cannot be a concept (i.e., it is not ‘discursive’) but must be a form of intuition (ibid., A24-5/B39). But before considering whether such additional characteristics rescue the detail of Kant’s forms of intuition, I shall consider the relevant details of geometry.

3.2.2. Euclidean geometry

Taken as a set of necessary truths (and not contingent facts about the world), the principles of geometry could not have been learned from experience. As Kant points out, ‘geometrical propositions are all apodictic, i.e., combined with consciousness of their necessity’ (*CPR*, B41).[60] But the existence of non-Euclidean geometries directly contradicts the assertion of such necessity and fixity. One of the significant differences, between the Euclidean and non-Euclidean forms of geometry, is the set of implications for the form of space. Euclidean geometry stipulates that (among other things) two straight parallel lines cannot meet. But the non-Euclidean geometry of Bolyai and Lobachevsky, for instance (Torretti 1978, 40-41), allows a definition of a straight line whereby two straight, parallel lines may still converge at a certain point.[61] Such a possibility stands in contradiction to the principles of Euclidean geometry. In other words, the contradiction between alternative possible geometries entails that, ‘on a consistent interpretation of “straight line” only one geometry can be true’ (Hopkins 1973, 6). For Kant’s notion of space, it is not so much the specific principles of non-Euclidean geometries that are problematic; rather, the very possibility of alternative but (potentially) incompatible geometries undermines the thought that Euclidean geometry is true by necessity, or that it is the only geometry.

[60] Kant uses the example that ‘all geometrical principles, e.g., that in a triangle two sides together are always greater than the third, are never derived from general concepts of line and triangle, but rather are derived from intuition and indeed derived *a priori* with apodictic certainty’ (*CPR*, A25/B39).

[61] For a more detailed discussion of non-Euclidean geometries, see: (Torretti 1978, chapter 2). For another discussion of non-Euclidean geometry, specifically regarding the impact upon Kant’s writing, see: (Hanna 2001, 264-280).

The emergence of non-Euclidean geometry entails two consequences for Kant's proposed constitutive conditions for inquiry (exemplified by space). First of all, the necessary *a priori* truth of Euclidean geometry is no longer a "truth" which is grounded anywhere at all. The question of why specifically Euclidean geometry is supposedly necessary ceases to be a meaningful question, and the termination of the necessity of geometry is precisely why '[t]he discoverers of non-Euclidean geometry … notoriously held the Kantian epistemology to be thereby refuted' (Schlick 1915/79, 154). The very presence of alternative geometries makes redundant any search for the grounding of the necessity of geometry; such a search would amount to asking how one might prove the truth of something which is not the case (Reichenbach 1965, 4). If such principles are revisable, then we have no reason to suppose that they might be fixed or necessary. Subsequently, the attempt to ground supposedly fixed or unrevisable principles is also made redundant; put another way, '[i]f Euclidean geometry, at one time the very model of rational or a priori knowledge of nature, can be empirically revised, … then everything is in principle empirically revisable' (Friedman 2001, 28).[62]

Secondly, in addition to the latter point, with the replacement of Euclidean geometry, the principles at the basis of scientific theories become entirely divorced from the form in which phenomenal experience is represented to us; not only does cognition no longer ground the principles of geometry but we are no longer justified in thinking that cognition supplies any constitutive principles of science at all. Scientific explanation is no longer bound to conform to our every-day experience. Kant's specific proposal for the basis of constitutive principles of inquiry (i.e., that such a basis is found in cognition) proceeds from a mistaken belief about what such

[62] Another development within geometry, which draws out the redundancy of an attempt to ground the necessity of Euclidean geometry, is the distinction between pure and applied geometry. Pure geometry is conducted on an *a priori* basis, and concerns purely formal rules and principles. Applied geometry, on the other hand, concerns the truth or falsehood of geometrical relations, with reference to empirical application. On the one hand, pure geometry affords no way of establishing how *a priori* principles may be applied empirically, and on the other hand, no necessity or *a priori* truth is given in the utility of applied geometry (Friedman 1992, 55). As Torretti points out, in a discussion of Helmholtz's geometry: '[o]ne thing is clear: *pure* physical geometry is indeterminate … This is a very powerful argument against the Kantian philosophy of geometry and is perhaps the main reason why the latter could not survive the discovery of non-Euclidean geometries: a priori knowledge of physical space, devoid of physical contents, is unable to determine its metrical structure with the precision required for physical applications' (Torretti 1978, 169-170).

principles are, as well as their supposedly fixed nature. There are no longer good grounds for believing that the principles underlying physics should be unrevisable and fixed, or that they should correspond whatsoever to our experience.

Suppose we were able to retain Kant's claim about the necessity of the *a priori* form of space, even in light of non-Euclidean geometry.[63] This would merely achieve the demonstration of a claim about the form of our phenomenal experience of space, rather than about any scientific or mathematical explanation of space and time. The gap between our experience of space, and the way in which space is conceptualised according to our best science, has become so pronounced that the former cannot ground the latter. Our experience of spatial awareness or reasoning (as a concern for cognitive psychology or biology) is independent from explanatory theories of space-time and other scientific concepts.[64] Any success in Kant's arguments for such features of space, therefore, will only apply to our experience, and will provide no help in answering the KQ.[65] As a result, no recourse to the further properties of space or time will help restore the notion that the constitutive principles of inquiry are grounded in cognition (Reichenbach 1965, 2); c.f.: (Schlick 1915/79, 178; 1922a/79, 325 and 31).

Put another way, theoretical explanation need not conform to any cognitive mechanisms or architecture by which our phenomenal experience is possible. Our experience of space may well rest on some innate set of cognitive capabilities,

---

[63] Friedman considers the idea that the intuition could potentially allow us to distinguish between *logically* possible representations of space, such that the *actually* possible model is chosen. Friedman argues, however, that the suggestion simply doesn't work, even on Kant's own terms, because the task of discriminating between different logical possibilities within geometry would be given to the intuition, and it is not at all clear how this should be possible, not least because the sensibility does not perform any functions of analysis or judgement (Friedman 1992, 99-104).

[64] The independence of theoretical concepts from common-sense notions is precisely one of the distinct criteria for naturalism; c.f.: chapter 2, §2.3.4.

[65] The 'infinite given magnitude' (*CPR*, A25/B39) of space, for example, is also motivated by the principles of geometry. For Kant, the form of space is infinitely divisible, so that 'one can only represent a single space' (ibid., A25/B39), rather than having the representation of many spaces (plural). The form of space as an intuition (as opposed to a concept) was important to Kant in order to account for the infinite divisibility of space, which is demonstrated by geometry (Euclidean geometry deals with continuous line extension, and allows for infinite divisibility). As there was no way, at Kant's time of writing, of conceptually representing infinite divisibility (Friedman 1992, 70-1), the *a priori* form of space must, therefore, account for the geometrical possibility of infinite divisibility, and must therefore also be defined non-conceptually (so Kant thought). Whilst our quantificational logic allows the conceptual representation of infinite divisibility, Kant had access only to syllogistic logic (ibid., 70-1).

perhaps as some biological mechanism, but however this works, our scientific concepts just aren't answerable to our day-to-day experience of phenomena.[66] Whilst Kant's proposed conditions are undermined, the KQ remains, and we may re-establish the very notion of the possible foundations for constitutive conditions of inquiry, whereby the scope of a new type of constitutive principle has actually been expanded (given that it is no longer restricted to phenomenal experience nor biological endowments of every human; in other words, the new set of constitutive principles may be established so as to be mind-independent; c.f.: §2.5.2). Note that the acknowledgement of the changing terms of scientific theories, as well as the splitting of scientific terms away from experiential or common sense terms, means that such a potential construal of new constitutive principles will fall in line with criteria for naturalistic inquiry (c.f.: chapter 2, §2.3.1, §2.3.4 and §2.3.5).

In chapter 2, I concluded that the conditions for the possibility of inquiry needed to be adapted so as not to exclude aspects of cognition from scientific investigation. We cannot assume that fixed components of cognition supply the constitutive principles for inquiry (or the capacities from which the principles may be derived). Neither can we assume that the constitutive principles of science are fixed and necessarily true. For precisely the same reasons that Kant's forms of intuition are undermined, the possibility is created to explore a new naturalistic set of constitutive conditions for scientific inquiry.[67]

[66] Similarities may well be found between Kant's notion of space, and the way in which we perceive and process spatial data. Recent studies, investigating the hippocampus of baby rats, provide examples of the potential for neuroscience to establish the basis of innate spatial reasoning capacities (Langston et al. 2010); (Palmer and Lynch 2010); (Wills et al. 2010). Results of such studies suggest 'that critical components of the brain's spatial representation systems are already in place when an animal first encounters an extended environment' (Palmer and Lynch 2010, 1487). The commentaries all explicitly characterise the results as offering support for Kant's model of space.

[67] C.f.: chapter 2, §2.5.

3.3. Newton and "relativized *a priori*" principles

3.3.1. A new conception of constitutive *a priori* principles

The remaining KQ is an entirely legitimate question, and one which retains the importance of the notion of constitutive principles as conditions of inquiry. In §3.3, I shall propose the details of RKN, according to a new understanding of constitutive principles which are neither fixed, nor directly determined by the forms of our experience. In retaining the importance of the role of constitutive principles, RKN remains a distinctly Kantian idea, in accordance with the KQ. Specifically, I shall demonstrate that we can identify 'relativized *a priori* principles' (Friedman 2001, 71) for any given theory, first for Newton's physics but also for Einstein's relativity theory. Cassirer advances such a system of relativized *a priori* principles, explaining that '[t]he system, in which we seek our intellectual orientation, is no individual perceptual body, but a system of theoretical and empirical rules on which the concrete … phenomena … [are] conceived to be dependent' (Cassirer 1910/2003, 183). These 'dynamic concepts and principles' (ibid., 185), or 'system[s] of coördinates' (Cassirer 1921/2003, 366) are subject to revision, in the 'continuous unfolding and evolution of … [such] systems' (Cassirer 1910/2003, 269).[68] Furthermore, they are embedded within a broader regulative *a priori* principle about the ideal goal of scientific unity of understanding, i.e., the regulative 'idea of the unity of nature' (Cassirer 1921/2003, 416).[69]

The possibility of any sort of *a priori* principle may be introduced by Reichenbach's initial characterisation of such ideas. As Reichenbach explains, '[b]ecause of the rejection of Kant's analysis of reason … [the notion] that the a priori statement is to be eternally true, independently of experience, can no longer be maintained' (Reichenbach 1965, 77). Despite this, two meanings may be identified

[68] Whilst the term "relativized a priori" is utilised by Friedman, who borrows it from Reichenbach (1965), the underlying notion is grounded in Cassirer's idea. I shall follow both Friedman (2001) and Cassirer (1910/2003; 1921/2003) for my arguments in this chapter. Friedman is explicit about Cassirer's influence, and also acknowledges drawing to an extent on the ideas of logical empiricists such as Reichenbach and Schlick (Friedman 2001, 66, n80). C.f.: (Cassirer 1910/2003; 1921/2003); (Friedman 1999; 2000; 2001); (Reichenbach 1965); (Ryckman 2005); (Schlick 1922a/79).

[69] Cassirer explicitly grounds these ideas in Kant's notions of constitutive principles, and the regulative idea of unity (Cassirer 1910/2003, 287; 1921/2003, 351-5, 394 and 416-8).

within Kant's notion of *a priori* principles: '[f]irst, … [*a priori*] means "necessarily true" or "true for all times," and secondly, "constituting the concept of object"' (Reichenbach 1965, 48).[70] In other words, upon this distinction, we may consistently reject the idea that such principles must be universal and unchanging, whilst retaining the *a priori* element as that component which provides constitutive conditions for the possibility of scientific inquiry. Identifying principles of this type allows us to retain the specifically Kantian notion of constitutive *a priori* principles, whilst discarding the idea that they should be necessarily fixed (Friedman 2001, 73).

Although *a priori* principles need no longer be fixed and universal, they retain some degree of necessity, in a particular sense. The constitutive principles are necessary only with regard to the relevant theoretical explanation, from within the context of a given stage of scientific understanding. The *a priori* principles are an essential requirement, relative to that theory. In other words, they are not logically necessary (in a universal sense), but are necessary under these particular conditions. Only under the presupposition of these principles do the relevant scientific theories become meaningful or applicable in the first place.

Logical positivists, such as Reichenbach and Schlick (for instance), developed their own variations of coordination principles, so as to establish the applicability of mathematical formulae to empirical phenomena, or in other words, to coordinate the two domains (Reichenbach 1965); (Schlick 1915/79; 1922a/79; 1922b/79). The respective notions, however, developed by Reichenbach, Schlick and Cassirer, are not identical.[71] Nonetheless, the foundation to such ideas idea is Kant's inquiry into the conditions for the possibility of scientific inquiry, with the intention

[70] Given the context of Kant's writing, it is entirely understandable that he should have taken the laws of Euclidean geometry to be fixed (Friedman 2001, 37), and that these two senses of "*a priori*" should be combined together.

[71] My argument does not rest upon the details of the differences, and so a full account of the debate, between respective conceptions of co-ordinating principles, is beyond the scope of this chapter. Both Cassirer and Reichenbach endorsed the notion of relativized yet specifically constitutive *a priori* principles (Ryckman 2005, 27). Schlick's conception was criticised, for instance, for not accommodating the relative and dynamic character of the principles (ibid., 50). Reichenbach ultimately conceded that his notion of coordination principles did not sufficiently answer the Kantian search for constitutive principles (ibid., 39). A particularly instructive explanation of the broader debate is provided by Ryckman (ibid., chapters 2 and 3), who argues in favour of Cassirer's 'significantly richer' notion of *a priori* principles (ibid., 46), largely with reference to general relativity. For more on the relationship between the "relativized *a priori*" and the logical positivists see: (Friedman 1999, chapter 3; 2001, part 1 chapter 2, part 2 chapter 1).

of establishing the underlying constitutive principles that made possible the formulation of theories of Newtonian physics in the first place.[72]

For the sake of explaining the detail of the relativized yet constitutive *a priori* principles, I shall categorise a given explanatory theory into three tiers, or a 'tripartite structure' (Friedman 2001, 80), within which we can locate the notion of relativized yet constitutive *a priori* principles. Friedman expresses these component tiers as 'three asymmetrically functioning parts: a mathematical part, a mechanical part, and a (properly) physical or empirical part' (ibid., 80). In combination, the purely mathematical and mechanical principles (from the first and second tiers) constitute the relativized *a priori* principles, or in other words the coordinating or "constitutive framework" of a given theory, as I shall refer to it (ibid., 36 and 83).

The mathematical part provides a set of mathematical principles; at this tier, the theoretical concepts are mathematically defined and constructed. Such constructions constitute the foundation for the next tier (the mechanical part), in which constitutive or co-ordinating laws are provided (of which the mathematical concepts are a part). The mechanical tier prescribes fundamental principles or laws, which function as the necessary co-ordination between the mathematical constructs and empirical phenomena. The third tier is the empirical element, wherein a theoretical explanation is provided. The empirical or theoretical part draws the mathematical foundations and lawful principles into a generalised explanation. As Friedman explains, the mechanical or lawful principles:

> set up a general correspondence between the mathematical part, on the one side, and concrete empirical phenomena, on the other, in such a way that the precise laws of nature formulated with the help of the mathematical part in fact have empirical meaning.
> (ibid., 80).

A correspondence or coordination is made possible, between the empirical and the mathematical tier, where such coordination is a crucial part of what makes the theory possible at all. Without the constitutive framework, the theories in question cannot

[72] The logical positivists aimed to follow suit; for example, 'Schlick aimed to do for Einstein's physics what Kant had done for Newton's, namely to explain and exhibit the special features of this physics that make it a model or paradigm of coherent rational knowledge of nature' (Friedman 2001, 14).

be so much as understood, let alone applied.[73] More specifically, the result is that the content of each component tier is not subject to equivalent empirical testing, in comparison to the other tiers (Friedman 2001, 80).

Although we can understand Cassirer's dynamical principles as an equivalent notion to the principles of a constitutive framework, he does not characterise such principles as being *a priori*.[74] Even so, Cassirer's dynamical principles are still taken as essential, relative to the chosen constitutive framework (in other words, they are "*a priori*" according to the revised sense).

Presupposition alone is not sufficient for a constitutively *a priori* principle; such principles must be those components which are essential and fundamental to our best physics (in other words, they are not merely any old assumptions, retained to support whatever belief one would like). As these relativized principles are those which serve best our current scientific understanding, they are also subject to revision, according to developments in our scientific knowledge. Just as explanatory theories are subject to revision, in light of new scientific discoveries or ideas, the *a priori* principles are also subject to revision and will not necessarily be preserved over theory changes. Explanatory theories demand that there be some set of constitutive principles, but the particular principles themselves for any given theory are not universally or logically necessary; i.e., they are necessary only relative to the scientific theory for which they form the constitutive framework. Such a constitutive framework is nonetheless *a priori* by virtue of the fact that it determines the form of the object of science, and constitutes some formal component, which in turn provides the conditions for the very possibility of inquiry under that theory; in other words, such conditions create the very possibility for the theory in question to perform its explanatory function.[75]

---

[73] For a more on the question of applicability of mathematics to physical sciences, see: (Steiner 2005); (Wigner 1960/79).

[74] Friedman recognises the point that 'Cassirer's conception of the a priori is purely regulative, with no remaining constitutive elements' (Friedman 2001, 66, n80). C.f.: (Cassirer 1921/2003); (Friedman 2000, chapters 6 and 7; 2001, 63-8); (Ryckman 2005, chapters 2 and 3).

[75] Note that the notion of such a constitutive framework allows an account of the conditions for scientific inquiry to be led by science itself (in accordance with the first criterion of naturalism), and that changes to the terms of scientific theory are also determined by scientific advancements rather than carrying any metaphysical weight or being restricted by philosophical stipulations (in accordance with the fourth, fifth and sixth criteria for naturalism). C.f.: chapter 2, §2.3.1 and §2.3.4-2.3.6.

3.3.2. Newton's classical physics

The constitutive framework for classical physics may be explained with reference to founding concepts, such as absolute space and time, or force, Newton's laws of motion and his theory of gravitation, and finally to the principle of 'restricted relativity' (Einstein 1920, 12) or in other words, the relativity of classical mechanics.[76]

The distinct notions of absolute time and absolute space formed the basis for the laws of classical mechanics, and for Newton's law of gravity. Newton's conception of absolute space, based upon Euclidean geometry, constituted some fixed entity or phenomenon with ontological independence from any other phenomena contained in space (Cushing 2003, 157); (Torretti 1999, 54-5). According to Newton's conception, whilst objects will have locations in space relative to other objects, they also have some "absolute" location, given the privileged frame of reference fixed to absolute space. Any given point in space has an absolute and not merely a relative location. Newton took this absolute space to be Euclidean and three-dimensional.

Absolute space is integral to restricted relativity. A Galilean co-ordinate system may be fixed to any rigid body as a spatial reference frame, and so we can measure spatial properties, or the motion of an object, with reference to a given inertial frame ("inertial", because the frame or rigid body, given for the fixing of the co-ordinate system, will act according to the law of inertia, and so will not be accelerating whether it is at rest or in uniform motion).[77] A particular object is taken to be at rest, and then this is used to supply a fixed reference body for a set of Galilean co-ordinates, from which any subsequent measurements are given. Even so, each reference frame is thought to bear *some* relation to absolute space, which

[76] "Restricted" relativity is distinct from Einstein's relativity theory, in ways which I shall demonstrate in the present section. I shall refer to it as "restricted relativity" so as not to confuse it with the relativity of the special or general theories.

[77] Newton himself did not conceive of inertial frames as such, and this is an updated way of conceptualising the notion in question, although the use of this term suffices for my point here. C.f.: (Friedman 2001, 36).

underlies all reference frames; this conception of space therefore grounds (for example) Newton's first law of motion (the law of inertia).

Any inertial frame will be in uniform motion or at rest (in other words, if it is in motion, it will not be accelerating). We cannot ascertain whether a given inertial frame is moving or whether it is at absolute rest. As Newton's laws hold in precisely the same way, in either case, they are said to be invariant over inertial frames. Nonetheless, we have the underlying notion of an object absolutely at rest, and therefore of a privileged reference frame, by virtue of absolute space, even though Newton's laws themselves do not single out this privileged reference frame. Because of such invariance, we cannot give preference to the motion of one body being somehow more "actual" than the other, and such an idea is the principle of relativistic invariance.

Newton's law of inertial uniform motion says that *if* a body were not acted upon by any other force, then it would continue indefinitely in uniform motion. But as there will always be a force of attraction between bodies, this is never actualised (Torretti 1999, 45-6). The principles of Euclidean geometry provide the framework which makes possible Newton's laws of motion, and so, ultimately, they ground the theory of gravitation (as well as the restricted relativity principle of the invariance of the laws through a transformation to a different inertial frame). In other words, Euclidean geometry (along with the calculus, for instance) provides the principles at the mathematical tier of the theory, contributing towards the constitutive framework. These mathematical principles allow the construction of theoretical concepts, defined formulaically via Newton's laws of motion.

Throughout Newton's theories and laws, phenomena are characterised lawfully and quantitatively, in mathematical formulae. Such formulaic expression of phenomena (i.e., as mathematical laws) do not constitute a reduction of some metaphysical truth or concept to a mathematical expression, but serve just as the actual definition of those phenomena, as well as tools for practical application (Holton 1965, 312). As such, the concepts (for instance, of mass, force, etc.) are not merely represented lawfully but are explicitly defined, formulaically, by those laws.

The concepts and explanations within Newton's theory of gravity are applicable only by virtue of the presupposition of the laws of motion. The mathematically defined laws empirically ground the gravitational theory (Friedman 2001, 74). In other words, the mathematical constructs form component parts of the laws of the "mechanical tier" of the constitutive framework. The demand for some presupposition is the necessary element. Euclidean geometry provides the particular mathematical framework for the possibility of mechanical laws which (in turn) define notions such as force, motion, and so on.

Newton attached a specifically quantifiable definition to the respective concepts in use, for instance, the term "force", by establishing that both the mass and proximity of two objects determine the gravitational pull between those objects.[78] Drawing on Kepler's laws, Newton was able to calculate the exerted force necessary for a given planet's orbit around another planet (for instance, the moon's orbit around the Earth); from here, he derived the inverse square law as a generalised description of the relationship between any two bodies. If the distance were to double, then the force would decrease by the inverse of the squared distance-increase: effectively, the distance is multiplied by 2, and so the force decreases by $1/(2^2)$. As a result of this, the gravitational force can never be zero, because the distance can increase indefinitely.[79] According to Newton's third law (of action and reaction), because gravity is constantly at work between all bodies 'as an action of each piece of matter on all other pieces of matter' (Torretti 1999, 49), then each piece of matter also continuously reacts to that gravitational force as well as generating its own gravitational force. In other words, any 'body that deviates from rest or uniform motion in a straight line bears witness to the action of external forces, as well as to their magnitude and direction' (ibid., 50). Newtonian mass can therefore be introduced as the measure of the resistance to acceleration given some force.

[78] Newton also distinguished between inherent force and impressed force. Inherent force is that belonging to any body of matter, and is that which results in the body continuing in a state of rest or continued motion, so long as no external force is exerted upon it. Impressed force is that which is exerted upon a body of matter, such that the body is disturbed from its inertial path or state of rest (Torretti 1999, 43-4).

[79] Consequently, there must always be some force acting upon a body, so long as there is always more than one body in existence.

Principles have therefore become the very conditions necessary in order for the development of theoretical explanation, which in turn enables us to make sense of the objectivity and lawfulness of the phenomenal world. These elements are also asymmetrical in character (Friedman 2001, 38 and 71), because 'without such general rules of coordination we simply have no idea what it means for concrete empirical phenomena to be described by the mathematical representations in questions—either correctly or incorrectly' (ibid., 77).[80]

With regard to Newton's physics, then, the calculus and Euclidean geometry formed the mathematical basis (i.e., the first tier); Newton's laws of motion constitute the fundamental laws and principles (i.e., the second mechanical tier), and therefore co-ordinate between the formulaically defined constructs and the empirical phenomena; the theory of gravity itself constitutes the empirical tier.

Newton declines to suggest exactly what gravitation itself amounts to, resisting the urge to go further than providing an account for the phenomena, via mathematical scientific laws or theory. Newton concedes that, although we may eventually find a further explanation about what gravity is (beyond its formulaic definition), the lack of such explanation did not make his theory any the less successful or substantive.[81] For Newton, it suffices that the mathematical definition accurately describes the phenomena in question, making unnecessary any further speculation of what gravity might be on a metaphysical level; the source or cause of gravity is not somehow missing, but rather, it is simply not needed (Torretti 1999, 77-9), and we have a purely mathematically defined concept. Newton explicitly acknowledges 'that it suffices to know the laws of gravity […without having to] devis[e] a hypothesis as to the cause of these properties' (Weyl 1949, 178), precisely because '[d]ynamics … requires no laws which extend to the causes of physical phenomena and to the essence of such causes; it is closed in itself as a representation of the regularities of phenomena' (Weyl 1932/2009, 54).[82]

---

[80] It is the distinctly asymmetrical nature and function of these tiers upon which basis Friedman argues against Quine's holism. The details of the argument are tangential to this chapter. For the full argument see: (Friedman 2001, part 1, chapter 2; part 2, chapter 1).

[81] As Holton points out, '[t]he mathematical law of gravity explains a wide range of observations; that is enough justification for accepting it' (Holton 1965, 326).

[82] Weyl frequently emphasises the mathematical formulaic status of physical concepts, explaining (for instance) that 'the concept of force becomes a source of new measurable physical characteristics of

In the present section I have explained the notion of a constitutive framework by which we are given a new construal of the conditions for the possibility of scientific inquiry, whereby the conditions are no longer mind-dependent. Although scientific inquiry still relies to some degree upon the cognitive capabilities of humans, as explained in chapter 2, such cognitive skills by no means amount to the full set of conditions required for scientific discovery to take place. We may, therefore, think of the set of conditions for inquiry, provided by the constitutive framework, as being mind-independent (c.f.: §2.5.2): whilst our cognitive capacities still play a part in establishing and utilising such conditions, the latter are not based directly upon, nor determined by, the universal cognitive make-up of the human mind.[83]

Having established a description of the constitutive framework with regard to Newton's physics, I shall progress to an explanation of such a framework with reference to Special Relativity (SR).

3.4. Special Relativity

3.4.1. The introduction of Special Relativity

In §3.4, I shall argue that despite the huge theory change in physics, SR may still be understood as relying upon a constitutive framework.[84] I shall provide the detail of

---

matter. […] Mass is the dynamic coefficient according to which inertia resists the deflecting force' (Weyl 1949, 149). Weyl explicitly highlights the entirely mathematical definition of gravitation (ibid., 168-70). Such a refusal to make the notion of gravity conform to previous conceptualisations, for instance, of contact mechanics, is also nicely illustrated by Weyl's account of Eddington's description of Kepler's laws in which 'physics has had to free itself more and more … from mechanical … interpretations' (Weyl 1932/2009, 49); as Weyl explains, 'Eddington recently spoke of the fact that in Kepler's conception of the world, the music of the spheres was not drowned by the roar of machinery' (ibid., 49). In other words, the lawfulness of the motion of the planets is not determined by mechanical phenomena, and no desire to make the world conform to mechanistic contact laws is to be imposed onto explanations of planetary motion.

[83] C.f.: The role of cognition may be resituated with regard to the conditions for the possibility of scientific theorisation, and I shall return to this idea. C.f.: §3.5, n.101 and n.103 (present chapter); chapter 5, §5.5.8 and §5.6.

[84] Friedman (2001) and Cassirer (1910/2003; 1921/2003) both identify relativized *a priori* principles within the general theory of relativity, as well as SR (Friedman 2001, part 2, chapters 2 and 3); (Cassirer 1921/2003, chapters 5-7). For my purposes, however, a discussion of SR will suffice.

this constitutive framework; I shall also argue, on the basis of the particular features of the constitutive principles, that SR may be seen as both revolutionary but also continuous, in terms of theory-change within physics. This holds importance for the role of Cassirer's regulative principle (which I shall address in §3.5).

With its basis in non-Euclidean geometry, Einstein's relativity theory emphasises further the difference between our phenomenal experience and scientific explanatory theories. For example, space-time replaces the individual concepts of space and time, and no one expects that we will suddenly start experiencing the natural world differently, just because of the advances in theoretical physics. We are not, for instance, going to have the phenomenal experience of the curvature of three-dimensional space just because we understand relativity theory; our intuitive or phenomenal experience of space 'tells us nothing about whether the concept of simultaneity is absolute or relative' (Schlick 1915/1979, 163). Fundamental sciences do not merely identify phenomena which are somehow "too hard" for humans to cognize (as though our sensory input in some sense fails to accurately represent the world in eleven dimensions); rather, the theoretical concepts of physics are not phenomena "out there" for physicists to use, but are conceptual mathematical constructs, developed specifically for the purposes of theoretical explanation. In other words, whilst the theories track the phenomena, the principles, concepts and laws themselves are the constructions necessary to make possible those theories in the first place.[85]

Prominent differences are easily identifiable between Newton's theories and SR. The notions of an absolute framework and of absolute concepts are no longer used, and the gap between experience and scientific explanation widens further still. Although motion is already shown to be relative according to Newtonian mechanics, SR posits no absolute inertial frame underlying the various possible reference frames. Demand is no longer placed upon theoretical concepts to supply the absolutes of a given theory, and empirical facts (e.g., the speed of light) are given an

[85] The mathematically defined concepts, therefore, do not posit ontological entities *qua* unobservable phenomena, but rather formulaic constructions, purely generated to serve the theory (and therefore without metaphysical commitment, just in the same sense as "gravity" was defined for Newton). Note that a concept-construction of this sort falls directly in line with the criteria of naturalism. C.f.: chapter 2.

axiomatic status so that the constants are principles instead of concepts; consequently, the objectivity of SR is grounded in the invariance of the laws themselves rather than the constancy of the concepts. As Schlick puts it, 'objective validity [is possible] only by sacrificing the absolute, in order to exchange it for knowledge of the relative' (Schlick 1922a/79, 333).[86]

A further significant feature of SR is that it may be understood as having both an ideal and empirical element; this description points to the fact that, just as with Newton's theory, SR has a specific constitutive framework, chosen on the basis of an ideal (or epistemological) concern. Within this very epistemological motivation, despite the changes involved, a certain underlying continuity can be identified in the move from classical physics to special relativity.[87]

Einstein notes that we can no longer expect to have any intuition of the objects of geometry:

> No knowledge or intuition of these objects is assumed but only the validity of the axioms, … which are to be taken in a purely formal sense, i.e., as void of all content of intuition or experience. These axioms are free creations of the human mind.
>
> (Einstein 1921a/82, 234).

Where Kant takes the forms of pure intuition to provide the constitutive *a priori* principles which are at the foundation of physical inquiry, with special relativity we have a new set of constitutive principles forming the conditions for the possibility of scientific inquiry.[88]

---

[86] In other words, we need to detach ourselves from the familiarity of how space and time appear to us; as Weyl says, in order '[t]o grasp the true meaning of the principle of relativity, one must get accustomed to thinking not in "space," nor in "time," but "in the world," that is in **space-time**' (Weyl 1922/52, 154).

[87] For further discussion of the relationship between classical physics and the special and general theories of relativity, especially with emphasis upon the continuous as well as revolutionary aspects, see: (Einstein 1927/82); (Friedman 1977); (Holton 1960/63; 1973/88, chapter 6). C.f.: (Friedman 2001, part 2, chapters 3 and 4).

[88] Despite this break with our phenomenal experience, we should not therefore conclude that Einstein's theory, in some sense, attempts to go beyond the phenomenal (i.e., into the noumenal). Rather, in Kantian terms, both Kant and Einstein are considering the domain of the phenomenal, insofar as Einstein continues to inquire into the lawfulness of the natural world. The widened gap between the concepts and theories of science and our phenomenal experience merely indicates that Kant was writing in a specific, scientifically situated, context.

Before Einstein developed SR, Maxwell's equations had been established in order to describe the electromagnetic field. Einstein observed, however, an asymmetry between Maxwell's equations and the Galilean transformations of the relativity principle of classical physics. Under the laws of classical physical theories, if one used as a reference frame a body travelling at the speed of light, an observer in that reference frame would end up with results which no longer matched the description given by Maxwell's equations. In other words, taking into account Maxwell's equations, there is an asymmetry between the inertial frame of the observer at the speed of light and of other inertial frames (i.e., Maxwell's equations were not Galilean invariant).[89]

Faced with a choice between Maxwell's recent findings in electrodynamics, 'of which the law of the constancy of the velocity of light *in vacuo* is a necessary consequence' (Einstein 1920, 19), and the restricted relativity of classical physics, the particular transformations and details of the long-established physics were challenged, in order that a relativity principle be retained. Whilst the details of classical physics were challenged, the commitment to relativity was not. Einstein insisted upon the preservation of invariance within the laws of physics, and therefore the preservation of some form of relativity principle.

3.4.2. The constitutive framework of Special Relativity

Einstein himself articulates the need for some constitutive framework, as a way of aligning mathematical laws with empirical phenomena, when he asks '[h]ow … it [can] be that mathematics, being after all a product of human thought which is independent of experience, is so admirably appropriate to the objects of reality' (Einstein 1921a/82, 233). Co-ordination is required in order to make sense of any meaningful application of mathematical formulae to empirical phenomena because

[89] As Cassirer points out, '[t]he effort to unite mechanics and electro-dynamics by carrying over the principle of relativity of the first into the second thus has to be given up: the Hertzian theory, which represented such an attempt, came into irreconcilable conflict with assured experimental results. Physical explanation stood before the dilemma of giving up a principle which had been verified without exception in all the phenomena of motion and which formed a corner-stone in the structure of classical mechanics—or of retaining it in its field but denying its applicability to optical and electromagnetic phenomena' (Cassirer 1921/2003, 370).

‘as far as the propositions of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality’ (ibid., 233).

In order to explain the constitutive framework of SR, I shall provide some basic detail about the relativity of space, time and motion. The relativity of space (by virtue of the relativity of motion) and time (by virtue of the relativity of simultaneity) highlight the components of SR which may be understood as a constitutive framework. Einstein explains the relativity of space via a thought experiment (Einstein 1920, 16). If a man walks at a uniform pace, along the length of a moving train carriage, the man’s velocity may be calculated either relative to the carriage or to the train tracks. According to classical physics, the definition of the man’s velocity will be relative to the chosen reference frame, whilst the laws of motion remain constant through any translation from one reference frame to another. Obviously, the man’s relative velocity is much faster with reference to the train tracks, than to the carriage. This should also be the case for any motion, if the laws of physics are truly invariant under transformation (that is, if they are symmetrical). We can compare the example of the walking man to the velocity of light propagation in a beam, shone along the tracks in the same direction as the train’s movement. If the speed of light is relative to the reference frame, as it should be if the laws are invariant, then it must be affected in much the same way as the man’s velocity (ibid., 18). The laws governing the speed of light should hold for both reference frames, so that (under classical mechanics) we would expect equivalent results for the case of light as for the case of the man. The *law* should be invariant, in other words:

> like every other general law of nature, the law of the transmission of light *in vacuo* must, according to the principle of relativity be the same for the railway carriage as reference-body as when the rails are the body of reference.
>
> (ibid., 18-19).[90]

What happens, however, is that the speed of light, rather than the law, remains constant across the transformation. This fact violates restricted relativity and, as a result, a contradiction arises. Consequently, either the newer laws of physics, of which the constancy of the speed of light is a result, or the restricted relativity of

[90] Here, Einstein is referring to restricted relativity.

classical mechanics, must be done away with. In other words, Einstein identified an asymmetry between classical physics and the principle of the constancy speed of light. With the introduction of a new relativity, symmetry is retained between the advances in physics and the principle of relativity. Einstein, therefore, chose to honour the preservation of the symmetry of physical laws, over the classical physics.

Einstein explained the relativity of time using a further thought experiment about simultaneity (Einstein 1920, 17-20). Take a railway embankment which serves as a fixed co-ordinate system. A train is travelling along the tracks at a uniform velocity. If one were to imagine a diagram of this, let's say that the train is moving from left to right; let's also say that A lies on the left and B lies on the right, so that the train would effectively be moving past A first, and then past B, across the diagram. The line AB runs parallel to the train. Now suppose two bolts of lightning hit the embankment at points A and B. "A" and "B" refer to points A and B on the embankment, and events A and B in which lightning occurs respectively at those points. A and B also correspond to points A′ and B′ on the train, which are aligned with A and B on the embankment, as the bolts strike. Let M be the midpoint of the line AB on the embankment; lines AM and BM are therefore equal. The lightning bolts occur so that the light from both events will reach an observer at M at the same time, i.e., the events will appear simultaneous to the observer at M (they are simultaneous with respect to the co-ordinate system of the embankment). Similarly, M′ is a point on the train, lying mid way between points A′ and B′ on the train. At the moment that events A and B occur, M is aligned with M′.

Taking *c* as the constant velocity of light propagation, the light from A must travel the distance AM and the light from B must travel the distance BM. As AM and BM are equal, and as *c* is constant, the light from both A and B must arrive at M at the same time. But fast as the speed of light is, some interval of time *t* still elapses between the moment of events A and B and the moment at which the light reaches the observer at M (this is the time taken for the light to travel the distances AM and BM). Point M is fixed, and so the distances AM and BM remain equal, irrespective of *t*. But the train is moving (away from A, towards B), and so in the interval *t*, M′ will have moved away from M and closer to B on the embankment. At the time of events A and B, M and M′ are aligned, but at the time the observer at M sees the light from the lightning bolts, M and M′ are no longer aligned. Consequently, the distances AM′ and BM′ (the distances the light is to travel, from the two events) will not be equal (after *t*, M′ will be closer to B than A, so AM′ > BM′). The light from event B reaches the observer (on the train) at M′, sooner than the light from A reaches the same observer at M′. To the observer at M′, events A and B are not simultaneous, whilst the very same two events do appear simultaneous to the observer at M.

Any two events A and B can, therefore, be either simultaneous or not simultaneous, depending upon the co-ordinate system to which they are referred. In other words, simultaneity is established relative to the given reference frame; because no co-ordinate system takes precedence, or has any "absolute" status over and above another, simultaneity cannot be an absolute concept but must necessarily be relative. Therefore, '[i]t became clear that to speak of the simultaneity of two events had no empirical meaning *except in relation to a given coordinate system* [my italics]' (Einstein 1919/82, 230). We can have a firm definition of simultaneity, but one which turns out to be relative rather than absolute, and because simultaneity is relative, there can be no sense in which time has any absolute value (if there were, an absolute simultaneity would also follow). Remembering that space is bound up in motion, we now have a notion of time which is relative to space and motion, and therefore, all three are relative and bound up together.[91]

In order to accommodate the relativity of space-time, so that symmetry is retained with the findings of electrodynamics, Einstein develops new invariance transformations. The transformation equations for SR provide the element of invariance, and the velocity of the propagation of light is given an axiomatic role in the equations (i.e., it constitutes a part of the formulaic expression of the laws of relativity). The invariance transformations contribute to the mechanical tier of a theory, which co-ordinates the principles at the mathematical tier (in this case, for example, the geometry of Minkowski space-time) and the empirical theory, i.e., the

[91] The theory of relativity draws upon reference to rigid bodies and clocks which are posited as the instruments of measurement, and he explicitly acknowledges the difficulty with these notions. The idea is that, if spatio-temporal measurements are relative, then this must also apply to any instrument used to measure such data, causing concern for the collection of empirical data. Einstein makes clear, however, that these are 'ideal' constructions (Einstein 1921a/82, 237). For a discussion, see: (Ryckman 2005, chapter 3).

theory of relativity, as the third and final tier. For SR, the mechanical co-ordinating tier consists of formulae which themselves utilise principled laws, as opposed to concepts. Put another way, it is the very conditions of measurement which provide relativity theory with the means for establishing objective and lawful measurements. This new constitutive framework may be emphasised by discussion of the importance of the light principle.

Split into its *a priori* and empirical parts, the special theory consists of the same type of constitutive framework as described for Newton's mechanics.[92] The relativity of space-time in no way denies the theory of its scientific objectivity; instead, the role of the theoretical constant is taken from the object of measurement within physics (i.e., the physical concepts involved), and given to the conditions under which such measurements take place.[93] In understanding these conditions, 'no constants are immediately given, but all must be *conceived* and *sought* before they can be found in experience' (Cassirer 1921/2003, 360); c.f.: (ibid., 358). In other words, the concepts of theoretical explanation may change, and as such, do not ground the objectivity of a theory; objectivity comes from the deliberate construction of laws, built on lawful principles.

The components from which special relativity is constructed (or indeed, those at the basis of Newton's theory of gravitation) are not just out there in the world, to be utilised in the construction of any scientific theory; rather, some constitutive framework must be "conceived" or "sought" such that we can even understand the

[92] Examples of a constitutive framework and relativized *a priori* principles are just as readily available for general relativity, where the principle of equivalence is now the 'central coordinating principle' (Friedman 2001, 98).

[93] On the subject of objectivity, Cassirer provides the following explanation: 'That physical objectivity is denied to space and time by this theory must, as is now seen, mean something else and something deeper than the knowledge that the two are not things in the sense of "naïve realism." For things of this sort, we must have left behind us at the threshold of exact scientific physics, in the formulation of its first judgements and propositions. The property of not being thing-concepts, but pure concepts of measurement, space and time share with all other genuine physical concepts' (Cassirer 1921/2003, 357). Here, when Cassirer notes that objectivity is "denied", this is in reference to general relativity, and does not mean that there is no objectivity *per se* but that there is no absolute fixity to the concepts *space* and *time*, given that '[i]n the general theory of relativity, space and time cannot be defined in such a way that differences of spatial co-ordinates can be directly measured by the unit measuring-rod' (Einstein 1916/97, 153), which alludes to the need for *ideal* measuring rods and clocks. The latter point of Cassirer's might be usefully compared to Einstein's remark that 'general co-variance … takes away from space and time the last remnant of physical objectivity' (Einstein 1916/97, 153).

components of the theory in the first place. In other words, only by virtue of the constitutive framework are we given theoretical constants in the first place. The very conditions of measurement are the source of objectivity, and these conditions of measurement (i.e., the mathematical principles and laws) are established by a given constitutive framework.[94]

We see in Newton's mechanical laws the beginnings of the decision to use formulaically defined scientific concepts in an axiomatic context, whereby mathematically constructed notions form the basis of the axiomatic laws:

> concepts, such as those of mass and force, … are ... no copies of particular contents given in perception ... What we possess in them are obviously not reproductions of simple things or sensations, but theoretical assumptions and constructions, which are intended to transform the merely sensible into something measureable, and thus into an "object of physics," that is, an object *for* physics.
> (Cassirer 1921/2003, 357).

3.4.3. The light principle and symmetry

Having established the details of the constitutive framework underlying SR, a closer examination of the role of the light principle brings into relief the idea that SR is just as much continuous as it is revolutionary. In other words, SR may be characterised as a continuous extension of particular methodological attitudes, also to be found in classical physics. Such continuity can be illuminated by drawing out the idea that SR has both an empirical and ideal element.

The velocity of light propagation, known as the light principle, embodies both the empirical and ideal aspects of SR. Whilst the light principle is based upon an empirical fact, its function is to act as a specifically *a priori* relativized principle; it becomes a component of the transformation laws or formulae, and therefore takes an axiomatic role (as opposed to standing merely as an empirical fact). Any

[94] Such a point is precisely what Cassirer means when he explains that 'thought *possesses* a relatively fixed standpoint only by *taking* it. In the choice of this standpoint, however, it is not absolutely determined by the phenomena' (Cassirer 1921/2003, 365).

coordinating principle must have some empirical element, such that it can 'serve the function … [it is] supposed to serve, namely, the coordination of some distinguished empirical phenomena to a particular mathematical spatio-temporal structure' (Friedman 2001, 87). For this reason, Einstein describes SR as a "principle theory"; in other words, '[t]he elements which form … [the] basis and starting point [of a "principle theory"] are not hypothetically constructed but empirically discovered ones, general characteristics of natural processes' (Einstein 1919/82, 228). In short, instead of physical concepts forming the components of the theory, principled laws (i.e. the light principle, in the case of special relativity) are used as such components.[95]

Einstein emphasises the empirical aspect to SR, explaining that '[t]he abandonment of certain notions connected with space, time, and motion hitherto treated as fundamentals must not be regarded as arbitrary, but only as conditioned by observed facts' (Einstein 1921b/82, 246). After all, the light principle is proved as an empirical fact: as Einstein makes explicit, '[t]he law of the constant velocity of light in empty space … has been confirmed by the development of electrodynamics and optics, and the equal legitimacy of all inertial systems' (ibid., 246), and it is this very empirical confirmation which motivates our abandonment of previous notions (Friedman 2001, 88). Furthermore, SR is formulated without reference to any entity for which there is no substantive empirical proof (i.e., the aether).

Although the light principle has a clear empirical basis, there is no empirical test which steers us towards giving the velocity of light propagation an axiomatic role, or indeed towards special relativity overall. The choice itself, therefore, is not empirically motivated and so the light principle amounts to a properly *a priori* constitutive principle. The given role of the light principle, therefore, turns upon a distinctly epistemological or ideal methodological attitude: the choice is made to value a new constitutive framework because it upholds theoretical symmetry. Such a new chosen framework preserves the notion of invariance whilst resolving the contradiction under the previous construal of relativity; furthermore, the framework

[95] Schlick notes the difference between the empirical aspect of special relativity, which can be deemed 'the relativity *principle* as a law', and which can be tested via experiment, and the ideal or theoretical aspect which can be termed the 'relativity *theory*', (Schlick 1915/79, 162).

posits no phenomena or entity the existence of which ‘cannot be demonstrated’ (Schlick 1922b/79, 345). It is because of the ideal or epistemological concern for the preservation of symmetry that ‘each measurement contains a purely ideal element; it is not so much with the sensuous instruments of measurement that we measure natural processes as with our thoughts’ (Cassirer 1921/2003, 365).

The preservation of invariance by virtue of some relativity principle, upon which Newton’s physics is grounded, is ultimately the same commitment which leads to the rejection of the classical physics. Such a concern for invariance is why Einstein insists that, in the move away from Newton’s physics,‘[w]e have here no revolutionary act but the natural continuation of a line that can be traced through centuries’ (Einstein 1921b/82, 246). Einstein, therefore, continued with the project of utilising specifically and mathematically defined concepts, as a means to the end of preserving invariance of physical laws across different reference frames. Both Newton and Einstein seek to respect the relativity principle, and uphold symmetry within physical theories. So the initial conflict with, and subsequent abandonment of, classical physics actually leads to a change made in the name of a common epistemological aim, upheld by both Newton and Einstein.

3.4.4. Theory change

Comparisons have been made between various formulations of coordinating principles and Poincaré’s conventions, because the “relativized” element of these constitutive principles requires that a choice is made between alternative founding principles.[96] An explanation of why this is not the case will illuminate another respect in which SR is both continuous as well as revolutionary.

The choice of one set of mathematical principles over another is what Poincaré referred to as a “convention” (Poincaré 1902/82, 65), where the term is divorced from the more familiar connotations of a standardised norm (say, in society or culture). Poincaré asserts that Euclidean geometry is the most convenient form for

[96] Schlick, for instance, compared Reichenbach’s principles with Poincaré’s conventions (Schlick 1922a/79, 333); at the same time, Schlick’s own ideas have been characterised as falling closer Poincaré’s conventions than Kant’s *a priori* constitutive framework (Friedman 2001, 14).

our experience, on the basis of the notion of simplicity (Poincaré 1902/82, 65).[97] Although choosing a convention upon the grounds of simplicity is distinctly motivated by theoretical or principled concerns, neither Einstein (1921a/82, 236) nor Cassirer (1910/2003, 186) characterises the constitutive components of SR as such conventions.[98]

The assertion that one theory is simpler than another is relative to the constitutive framework in question; the simplicity of (say) geometry is, therefore, just as dynamical as are the constitutive principles themselves. The extent to which Einstein explicitly agrees with Poincaré, therefore, 'is not a concession to conventionalism' (Ryckman 2005, 64). Einstein explains that if the principles at the basis of SR are understood as conventions, then the importance of the relative and dynamical nature of simplicity (as well as other relative notions) becomes obscured. For Cassirer as well, dynamical principles are also conventional only insofar as some choice must be made; but the fact that the choice itself is dynamical is not captured by the notion of conventions (ibid., 41 and 67).

The selection of SR over the Lorentz-Fitzgerald theory may also appear similar to a conventional choice, in Poincaré's sense; but the possibility of comparing the respective theories depends upon a pre-established choice of constitutive framework. The Lorentz-Fitzgerald theory and SR are equivalent empirically (Friedman 2001, 52), but are built upon distinct constitutive frameworks; the choice between the two is therefore unlike normal cases of underdetermination (whereby two opponent theories will supply alternative explanations from the common foundation of the same constitutive framework). As no constitutive starting point is agreed upon, underdetermination cannot even enter into the question.[99]

[97] For more on Poincaré's characterisation of chosen theories as conventions, see: (Poincaré 1902/82, chapter 3, especially 55-65; 1906/82, chapters 3 and 5).
[98] C.f.: (Ryckman 2005, 56); (Schlick 1915/79, 169). For more detail on Poincaré's influence upon relativity theory, see: (Einstein 1921a/82); (Friedman 2001, part 2, chapter 4). For more on the relationship between foundational issues in geometry and relativity theory, see: (Friedman 1999, chapter 2). For more on the relationship between Poincaré's conventions, the logical positivists and relativized *a priori* see: (ibid., chapters 3 and 4).
[99] Again, 'the special theory of relativity is such that its advantage over other explanations … is based not so much on its empirical material as on its pure logical form, not so much on its physical as on its general *systematic* value' (Cassirer 1921/2003, 354).

Because of the lack of common constitutive framework, notions like "simplicity" cannot have the same meaning. Metrics such as simplicity (as a means by which to respond to underdetermination) may be applied from within the basis of a particular constitutive framework, but only after such a framework has been decided upon. The very notion of simplicity is determined by the constitutive framework in question, and can only be meaningful relative to that framework. In other words, the empirical evidence for, or the simplicity of, a theory is only possible from within the relevant constitutive framework (Friedman 2001, 87-8); (Schlick 1915/79, 164).

The hypothesis of the existence of the aether was specifically rejected (and not just replaced) by Einstein on principled grounds, because of his insistence that 'what cannot be demonstrated should not be assumed to exist. This, of course, is a philosophical demand, not an experiential proposition' (Schlick 1922b/79, 345). Furthermore, the aether hypothesis does not supply the same sort of coordination, between mathematical principles and phenomena, as is achieved by the light principle. Although the existence of the aether plays a role within the Lorentz-Fitzgerald theory, this fact in itself does not give it an equivalent role to that of the light principle. The aether-hypothesis appeared as a descriptive backdrop to the Lorentz transformations, but such a feature is not sufficient in order to amount to a constitutive principle (principles within a constitutive framework must do more than merely remain consistent with empirical findings); (Friedman 2001, 62).

The significance of SR, in comparison to the Lorentz-Fitzgerald theory, is Einstein's unique interpretation of the Lorentz transformations; the speed of light is featured in both theories, and therefore figures in the transformations of each theory, but only under Einstein's interpretation was it given an axiomatic and therefore constitutive function (Schlick 1915/79, 161). It is the variation in the function of the velocity of light, in the respective theories which means that SR could not be chosen on the grounds of any experimental outcome, but on a principled basis, because empirical proof is only given meaning by the choice of one of the two constitutive frameworks, under the respective interpretations of the transformations (ibid., 164).

Despite the contrast in the respective interpretations, Einstein's revolutionary theories are also distinctly continuous with then-contemporary work in physics, in certain respects. The constitutive use of the light principle was only made possible within the context of the recent discoveries in physics, within electrodynamics and optics. To this extent, SR builds upon previous scientific discovery: Einstein transforms the *status* of an empirical law, but this is only possible in a move which is continuous with the work done to establish that law in the first place. According to Einstein, SR is 'simply a systematic development of the electrodynamics of Maxwell and Lorentz, pointed beyond itself' (Einstein 1919/82, 230).

3.5. Cassirer's regulative principle of unity

With the introduction of a new constitutive framework, the previous framework loses its meaning entirely. To even try to reformulate the old framework within the new set of constitutive principles will necessarily mean the older set of principles losing its efficacy and applicability *qua* some framework by which mathematical concepts and axiomatic principles are defined (Friedman 2001, 99).

It is, in fact, precisely because of the possibility of scientific revolution and changes in constitutive framework, within the continued expansion and cohesion of human understanding, that some more universal or persisting element reveals itself. As Friedman explains, '[i]t is precisely this revolutionary experience … that has revealed that our knowledge *has* foundations in the present sense: subject-defining or constitutive paradigms whose revision entails a genuine expansion of our space of intellectual possibilities' (Friedman 2001, 46).

We may refer to such an underlying foundation as a "meta-framework" (Friedman 2001, 44), where the latter is not identical to Cassirer's regulative principle; rather, the meta-framework provides the conceptual space for a regulative principle. [100] It is across theory-change, from the position of a meta-framework, that

[100] Neither the three tier model of scientific understanding, nor the over-arching meta-framework, should be understood as permanent or fixed. The present model of scientific understanding is not used by Friedman as a means of establishing 'differing degrees of certainty or epistemic security'

the foundational unity is supplied, by which revolutionary change and the relative character of constitutive principles are to be understood at all. The meta-framework position is illustrated, for instance, by the philosophical discussion surrounding geometry, to which Einstein paid attention (Friedman 2001, part 2, chapter 4).[101] Meta-frameworks are 'indispensable … as a source for suggestions and guidance—for orientation, as it were—in motivating and sustaining the transition from one paradigm or conceptual framework to another' (ibid., 46). It is within the context of the meta-framework that Cassirer's regulative *a priori* principle finds its force, and provides the possibility of understanding such scientific changes as *both* revolutionary and continuous. Whilst the meta-framework may also be subject to revision, Cassirer's regulative principle is thought to be constant, precisely because it is regulative and guides us even within meta-framework debates and thought.[102]

Cassirer's *a priori* (but not relativized) principle is regulative as opposed to constitutive, and posits the notion is of a wholly unified and completed science, directly developed from the Kantian notion of a regulative ideal. The ideal of the completion of science is, therefore, held across any revolutions or changes in scientific theories, and is consequently an *a priori* element in an absolute or fixed sense. We can encompass the notion of the regulative *a priori* ideal within the notion of the relativized *a priori* described so far (i.e., the notion of a constitutive framework) so that the domain of constitutive principles is always bound up with the ultimate aim towards scientific unity and completion (Friedman 2001, 64-6).

(Friedman 2001, 46), and does not necessarily entail any particular position regarding scientific realism or anti-realism (ibid., 64 and 118). Therefore, it is a way of making sense of the distinctly epistemological issues involved in theory change. The cohesion and continuity should be understood as holding between constitutive frameworks, and not between the framework and the reality of the phenomena world (whatever that may be).

[101] Note that the complex relations between previous or co-existent theories and SR, as discussed in §3.4.4, and between SR and the ideas developed within the meta-framework, demonstrate the complexity of factors which contributed to the formation of SR. As such, SR exemplifies a theory developed upon distinctly mind-independent conditions. C.f.: chapter 2, §2.5.2; §3.3.2 above.

[102] Friedman uses the combined model of a three-tier concept of theories, alongside the meta-framework, as a more successful alternative to Kuhn's articulation of the possibility of scientific rationality and his proposal for avoiding conceptual relativism across theory change (Friedman 2001, 47-57). Kuhn's idea (1962/96), according to Friedman's understanding, is that there are certain trans-paradigm metrics of rationality (e.g., simplicity) which allow us to choose between and develop new theories; c.f.: (Friedman 2001, 50-1). The present chapter does not rest on this argument, but for further discussion, see: (ibid., part 1 chapters 2-3, part 2 chapter 3).

Cassirer still makes clear that, for any given theory, some intellectual choice is made regarding the constitutive framework, and so does not deny the relativized aspect of scientific theories; the regulative *a priori* ideal, on the other hand, persists across scientific development and is therefore not relative in that sense. His point is that '[e]ach new physical hypothesis erects, as it were, a new logical system of coördinates, to which we refer phenomena, while nevertheless the doctrine is retained as a regulative idea for investigation that all these systems converge on a certain definite limiting value' (Cassirer 1921/2003, 366). Whilst we have a set of relativized constitutive *a priori* principles (i.e., those principles given by the constitutive framework), we understand their relative character precisely because we have a regulative notion of this 'ideal state of [the] completion [of science] … for which there is no guarantee at all … [but which] we are always under the obligation to keep seeking' (Friedman 2001, 64). Such a notion of ideally completed science is precisely Cassirer's idea of a regulative *a priori* principle.

Cassirer's regulative ideal, then, is upheld even across the change of constitutive frameworks, as, '[i]n the midst of the change of particular theoretical instruments of measurement, the critical theory holds fast to the thought of the unity of measurement, which indeed signifies for it no realistic dogma but an ideal goal and a never-to-be-concluded task' (Cassirer 1921/2003, 366). Cassirer's emphasis, upon the desire for symmetry, and upon the simultaneous features of theoretical transformation and necessary continuation, precisely echoes Einstein's explicit epistemological motivations (c.f.: §3.4): [103]

> Thus it is seen that the initial contradiction, appearing between the principles of mechanics and those of electrodynamics, has shown the way to a far more

[103] Although no constitutive principles are given in the structure of the mind, it is by virtue of some aspect (or aspects) of human cognition that we may so much as think of this regulative unity. Therefore, whatever component of cognition this is, it is also necessary to some degree for theory construction as well as theory change. Constitutive principles demonstrate that the vast range of contributing factors, to the complete set of conditions for scientific inquiry, have a scope way beyond the individual mind; for instance, the cumulative progression of science relies on the previous establishment of years of work, as Einstein indicates when he describes his theories as the 'systematic development' of the work already done in physics (Einstein 1919/82, 230). The scope of such a full set of conditions extends in many respects beyond the individual mind, and by virtue of this fact, we may understand the respective conditions as being mind-independent; but, nevertheless, the full collection of any such conditions includes our ability to think of an ideal unity, where the modality afforded by unity is a crucial part of the conditions for theorisation. In other words, RKN can be thought of as redefining or resituating at least some part of the specific role of cognition within a much broader set of conditions for scientific inquiry or theorisation. C.f.: chapter 5, §5.5.8 and §5.6.

> perfect and deeper unity between them than previously existed. And this result was not reached entirely by heaping up experiments by newly instituted investigations, but it rests on a critical transformation of the system of fundamental physical concepts.
> (ibid., 373).

The achieved unity, referred to here, highlights the common aim of both Newton and Einstein to uphold symmetry, within their respective relativity principles. Unity, in other words, is not merely maintained but actively sought.

We can see precisely such a meta-framework in place, in the emergence of Einstein's physics, given the principled prioritisation of the notion of symmetry, a concern which entirely follows on from Newton's restricted relativity. Cassirer, for instance, points out that the decision to transform an empirical law to an axiomatic principle is guided by the ultimate aim towards 'systematic unity and completeness, of scientific exposition' (Cassirer 1921/2003, 365). The demand for symmetry instantiates the explicit importance given to the notion of an underlying ideal unity that persists throughout scientific discovery, as well as an explicit aim towards, and demand for, such unity within the formation of theories. Einstein, in other words, may be seen as explicitly upholding the regulative principle of unity in his expectation that scientific theories should be characterised by symmetry (which in turn demands the modal commitment to the lawfulness of theoretical explanation, even where such theories are subject to change). In other words, unity is demanded for the very possibility of cohesive generalisations; indeed, the notion of unity is precisely that which makes possible the modality of theoretical generalisation.

Furthermore, Einstein paid great attention to the philosophical debate surrounding the mathematical principles which became the constitutive foundations of relativity theory (Friedman 2001, 108 and 114). The debates about geometry and symmetry, in which Einstein took such great interest, are aspects of inquiry and intellectual exchange belonging to the meta-framework. Such considerations and philosophical debates allow the development of new ideas, from the foundations of already-established concepts or fields of investigation (by variously building upon or transforming the established thought). The meta-framework therefore contributes to the set of conditions which makes possible both the continuity from theory to theory, as well as the revolutionary aspect of theory change.

The discussion and debates of the meta-framework, as a set of broadly epistemological or philosophical concerns, are free to change as well. Cassirer's regulative *a priori* principle is given at the level of the meta-framework, and also carries over into a given constitutive framework, although its role remains regulative. It is, as it were, that guiding element within a constitutive framework, steering us towards our goal of unified scientific understanding, as well as serving a regulating function within theory development. It is the very desire for scientific unity (in Cassirer's terms, the possibility of a completed science) which motivates the development of new theories, and subsequently enables both the continuity over, and revolutionary aspect of, theory change.

The notion of a completed science is a purely regulative ideal, guiding our inquiry from one theory to the next; we can conceive of this regulative principle as being necessarily combined with any given constitutive framework. Put otherwise, the relativized constitutive framework is contained by (or is combined with) this regulative principle. It is precisely our understanding of this ideal by which we can understand the *a priori* principles as specifically relative; '[t]hat every realization, which the demand of thought for ultimate constants can find within the empirical world is always only conditioned and relative, is guaranteed by the unconditionality and radicalism of precisely this demand' (Cassirer 1921/2003, 365). The point is that we only get the notion of the "relativized" by having some ideal notion of a completed and unified whole, against which relativization is to make sense in the first place. As Cassirer explains:

> these "relativizatitons" are not in contradiction with the doctrine of the constancy and unity of nature; they are rather demanded and worked out in the name of this very unity. The variation of the measurements of space and time constitutes the necessary condition through which the new invariants of the theory are discovered and grounded.
> (ibid., 374).

Recall that this overarching awareness of the progression of science, guided in a regulative sense by the notion of the completion of science, is a specifically Kantian idea. The possibility of constitutive frameworks, containing relativized *a priori* principles, in combination with the regulative *a priori* ideal of Cassirer's principle, is precisely the broad Kantian naturalism I propose as an updated answer in response to the KQ. RKN, therefore, supplies a persisting Kantian yet naturalised approach, which remains consistent with the relevant developments in science since Kant's writing.

Einstein may be said to aim at Cassirer's principle, in his commitment to the notion that there should be symmetry to be found in the laws of physics. Einstein, therefore, provides an example of a scientist upholding the regulative ideal of a unified science; such an example is precisely what makes the metaphysical endorsement of the PPC and the PNC permissible as a naturalistic position.

3.6. Conclusion

In this chapter I have examined and defended the precise detail of a Revised Kantian Naturalism (RKN). As such, RKN amounts to the notion of a constitutive framework in which relativized *a priori* principles are established, as the conditions for the possibility of inquiry under a given theory, in combination with the regulative principle of unity. Having highlighted the components of RKN (the constitutive framework and the principle of unity) across both Newton's physics and SR, I have also demonstrated that RKN provides an understanding of scientific rationality whereby theory change may be characterised in terms of continuity at least as much as in terms of scientific revolution. The emphasis placed by Einstein, upon the demand for symmetry, exemplifies the way in which a regulative ideal unity is presupposed within the practice of scientific theory formation. The notion of a regulative ideal of scientific unity is significant for chapters 5 and 6, and so Cassirer's regulative principle will be examined further in chapter 4.

Chapter Four:
Regulative Boundaries and the Notion of the Noumenal

4.1. Introduction

In chapter 3, I have defended RKN (Revised Kantian Naturalism), a core part of which is Cassirer's idea of the regulative *a priori* principle of a unified science. The present chapter serves the twofold purpose of providing a deeper understanding of Cassirer's regulative *a priori* principle, as well as an argument for the claim that such a principle is both distinctly Kantian and also necessarily a part of RKN.

In order to explicate the above points, I shall argue that the Noumenal in its correct construal, according to Kant, is a regulative boundary notion of the totality of thought; I shall refer to such a construal, for which I argue, as a "noumenal-phenomenal boundary".[104] The notion of a Regulative Boundary for scientific inquiry (RB) constitutes the naturalised form of the noumenal-phenomenal boundary, and also amounts to Cassirer's regulative *a priori* principle. The noumenal-phenomenal boundary, therefore, is not identical to the RB, but is the fully Kantian idea, before it is adapted (so as to constitute the RB); the RB, in other words, is the notion which, together with the constitutive framework, characterises RKN.

[104] Given the wide range of interpretations, and the various terms used, I shall use "Noumenal" (capital N) to refer to Kant's notion in the broadest sense, prior to committing to any interpretation (for instance, of the noumenal-phenomenal boundary).

4.2. A regulative boundary for conditions

Two points justify the claim that the RB is specifically Kantian, according to the modified construal of RKN. First of all, some broad notion of the unconditioned, *qua* regulative boundary, still follows from RKN (c.f.: chapter 3, §3.5). Secondly, Kant specifically applies the regulative principles of Reason to inquiry, towards the end of the *CPR*, and therefore brings the regulative use of Reason, *qua* an application of the noumenal-phenomenal boundary, directly to bear upon the issue of naturalistic inquiry.

In the present section, I shall argue for the first of the two claims above, namely, that a broader naturalised construal of the unconditioned follows from the naturalised conditions for the possibility of scientific inquiry (or, in other words, the notion of the principles within a constitutive framework). Put otherwise, the general concept of the unconditioned automatically falls out from the concept of conditions, by definition. Once we specify naturalised conditions, the derived boundary notion is also consistent with naturalism. As I wish to show that the boundary notion follows from conditionality *per se,* for this section only I will avoid reference to Kantian terminology. The argument in question runs as follows:

1) For any human activity or event (for instance, the practice of scientific inquiry) there will be some set of empirical conditions in order for that activity or event to take place (such conditions need not be necessary, but the very presence of any conditions at all is itself necessary). Let us call the notion of such conditions (whatever they may be in particular cases) condition-set X.
2) Any conditions necessarily impose constraints and therefore have limits, which limits in turn can be understood as the boundary at the limits of those conditions. Put another way, there is some totality generated by the full extent or application of those conditions. For the possibility of the containment of that totality, there must be some closure so that the “whole” is unified, *qua* a totality. In turn, closure entails some edge or boundary, i.e., the boundary itself is conceived as that against which the totality is bounded, and amounts to the unconditioned. This boundary is formed necessarily as the limitation to those conditions, regulating their totality.

3) Our set of conditions X therefore implies the idea of the unconditioned as a boundary notion.

Premise one may be taken as self evident, on the basis that any human activity, experience, event, etc., is necessarily made possible by the presence of conditions which generate its possibility (however complex, or indeed trivial, such conditions may be). It is impossible for any aspect of existence or experience to occur under "no conditions". All circumstances, events, experiences and so on, must be conditioned in some respect, given that we are finite creatures, and given that there is distinction, division and individuation in the natural universe.[105]

Regarding the second premise, conditions automatically demand us to think of extension or continuation beyond those conditions, i.e., that which constitutes the unconditioned. Were a totality not contained by the notion of a boundary (whatever provides closure for that totality), then it would not actually be a totality; it would be infinite, indefinite, or something less than the total. By definition, a limit is imposed from the very stipulation that there are conditions; a limit functions only at the potential exclusion or prohibition of some possible continuation or extension.

Put another way, the notion of "conditions" presupposes the specification of certain criteria to be met; conditions are, therefore, necessarily finite. Given our capacity to conceive of that which supersedes the finite (the indefinite, infinite continuity or division, etc.), we cannot help but conceive of continuity beyond a given limit. A boundary implies something against which its contents are bounded, in other words, some continuation or extension.[106] In other words, the limit of the conditions means the imposition of a limiting boundary; the boundary, in turn, implies the contained totality of those conditions (even where this totality can only be a heuristic idea). The totality of conditions is therefore bounded by the unconditioned.

[105] There may be deep theoretical explanatory models in physics within which no such individuation obtains, but the point is that, on a more localised scale, we do identify "individuals" (animals, objects, categories for classification, etc.).
[106] The term "extension" carries implications of spatial metaphor; such terminology, however, can easily be discarded. We may readily think of abstract examples (for instance, numerical extension).

Recall that RKN endorses the presence of some set of conditions as the particular principles given, under the constitutive framework, relative to a given scientific theory. Such conditions are not fixed, but there is nonetheless the demand that a constitutive framework be in place, whatever the principles happen to be.[107] We may replace condition-set X (above) with conditions under RKN, and the naturalised boundary notion follows.

The relativity of these principles may appear to be at odds with the notion of this totality. The conditions are repeatedly replaced and updated, and the principles are only ever relative to a given constitutive framework. As such, any fixity of principles is necessarily off the table; the notion of some unified totality may seem to demand some sort of fixity, but is not a problem. We can think of the totality of all and any such relativized *a priori* principles (the full set of all eventually utilised relativized principles, and not just one particular set which is subject to change), along with all other conditions for scientific inquiry.[108] From the full set, we are then able to think of the full totality which follows, of a completed science. Nonetheless, we are not permitted to think of this final science in any constitutive sense, and so the notion must only be a regulative guide. The RB therefore constitutes the following:

> The Regulative Boundary (RB) is the ideal notion of the totality of a unified science, thought of as a heuristic boundary which is to guide our continuing inquiry.

As a regulative notion (i.e., a guiding notion which is not constitutive), we need have no idea about its particular contents (who knows what a completed or totally unified science might look like). At the same time, it is a naturalistic notion (in line with RKN and the KQ), and so does not carry any metaphysical baggage (beyond the modality inherent in the claim; c.f.: chapter 2, §2.3.2).[109]

---

[107] The relationship between the theory and constitutive principles is asymmetrical, because the theory depends upon the constitutive mathematical and mechanical principles in order to be so much as meaningful and applicable (in other words, under a different constitutive framework, the same theory would not be applicable to empirical phenomena).

[108] The constitutive *a priori* principles relative to a particular stage of theoretical explanation do not amount to the full set of conditions for scientific inquiry or explanation, not even for that given stage.

[109] Recall from chapter 2 that methodological naturalism allows us to hope for such a unity of science, or use it as a guiding notion which regulates the way in which we continue to inquire, whilst simultaneously acknowledging that humans might never actually achieve a unified science for one reason or another.

We can also examine the use of Reason in the second *Critique* (Kant 1788/2004) and third *Critique* (Kant 1790/2000), but such an examination is beyond the scope of this chapter. Examination of the material in the *CPR* suffices for my argument, although I shall briefly refer to the notion of the sublime from the third *Critique* (Kant 1790/2000) as a supplement to my discussion.[110]

4.3. Criticisms of the Noumenal

4.3.1. Unthinkable objects

In §4.4 onwards, I shall defend the noumenal-phenomenal boundary as a properly regulative boundary notion, which avoids any implications of a distinct but inaccessible realm or its contents (for instance, noumena *qua* objects). I shall also defend the possibility of a "Broader Reading", according to which this construal of the Noumenal is possible.[111] Finally, I shall mount a defence of the noumenal-phenomenal boundary against prevalent criticism in the literature. Before doing so, therefore, in the present section, I shall review the main criticisms and disagreement in the literature, and shall demonstrate how these objections arise from Kant's writing.

Criticisms of the Noumenal (upon various interpretations) date back to Kant's contemporaries, such as Jacobi (Guyer 1987, 335); (Beiser 1987, chapter 4, especially 122-124). Many of the readings of the Noumenal treat things in themselves, or noumena, as objects (in a way comparable with, or at least analogous to, phenomenal objects). Kant often uses the terms "thing" or "things in themselves" when discussing the Noumenal, and so there is (understandably) a great deal of

[110] Cassirer is emphatic that the *CPR* alone is not sufficient for providing the full dynamic character of the noumenal, and that for a complete understanding, an examination of the second *Critique* (Kant 1788/2004) and third *Critique* (Kant 1790/2000) is required (Cassirer 1918/81, 216-217). For an especially comprehensive examination of these issues, see: (ibid., chapters 5-6).

[111] I do not take the Broader Reading to be identical with the noumenal-phenomenal boundary; the Broader Reading is the position from which to read Kant's texts, and the noumenal-phenomenal boundary is the notion we derive as the correct construal of the Noumenal, resulting from the latter reading.

subsequent contention surrounding Kant's ideas. Such a focus upon objects leads to contradictions, which are taken as reasons to reject wholesale the notion of the Noumenal, and indeed many of the criticisms do not allow room for the possibility of the Broader Reading, or of the noumenal-phenomenal boundary as a legitimate construal.[112] Where something like the noumenal-phenomenal boundary is acknowledged, commentators still tend to place a great emphasis on the notion of noumena *qua* objects.

The treatment of the Noumenal as a set of objects is, nonetheless, understandable, given that Kant initially introduces the Noumenal by a comparison between noumenal and phenomenal objects respectively, which is even explicit in the title of the section 'On the ground of the distinction of all objects in general into *phenomena* and *noumena*' (*CPR*, A235-60/B294-315). Kant explains that:

> [a]ppearances, to the extent that as objects they are thoughts in accordance with the unity of the categories, are called *phaenomena*. If, however, I suppose there to be things that are merely objects of the understanding and that, nevertheless can be given to an intuition, although not to sensible intuition ... then such things would be called *noumena*
> (ibid., A248-9).

Here, "noumena" are presented as those "things" (with emphasis on their status as objects) which are thought through the pure concepts of the understanding (so, without synthesis between the categories and sensible intuition, as is the case for any object of experience). From such a characterisation of the Noumenal as a set of objects, two major and frequent criticisms of the Noumenal arise; the two issues in question may be characterised as the problem of the unknowable, and the problem of causation or affect (Van Cleve 1999, 153), to which I shall turn now, one at a time.

The first difficulty revolves around how we can know that the Noumenal is inherently unknowable; we cannot form any judgements about the Noumenal, but still attempt to do so even in making that very point (Priest 2002, 82). As a result,

[112] By suggesting that a commentator does not consider the Broad Reading, I do not intend to imply that they pay no attention to how Kant's ideas develop or hang together overall, or that they have not undertaken careful textual analysis.

Kant's notion of the Noumenal has been diagnosed an 'aspect of incoherence' in Kant's thought, arising from 'distortions and perversions' (Strawson 1966, 249).[113]

The perceived difficulty of our knowledge of the Noumenal is put well by Priest, when he explains that 'Kant [is] writing a very large book at least purporting to inform us about ... noumena. His own theory would therefore seem to be both within and without the known' (Priest 2002, 80). More specifically:

> if I can think about certain objects, then I must have some way of fixing on them mentally; and I can use this fact to make them the subject of some assertion ... Hence noumena are precisely contradictory objects beyond the limit of conception
> (ibid., 82).[114]

The idea is that, in the process of making the judgements needed, to explain that we cannot make claims about these noumena, Kant still ends up applying the categories in order to point out that this is precisely what one cannot do:

> When Kant says that noumena may be supposed to exist ... he deploys the Category of existence; when he says that they are not in time, he deploys the Category of negation. Even the statement that the Categories cannot be applied to noumena deploys the Categories of possibility and negation!
> (ibid., 81-2).

As a result, we are able only to understand and have knowledge of that to which we can apply the conditions for any experience. If we are supposed to somehow conceive of noumena, or a noumenon, it looks as though we necessarily must involve the concepts of the understanding, as conditions for experience and judgement, and at the same time must necessarily not draw upon such conditions. If we assume that noumena are such "things", beyond the possibility of judgement, then certainly a contradiction arises: to assert the possibility of 'things about which we cannot judge ... [is to] existentially quantif[y] over them, and so appl[y] the Category of plurality' (ibid., 82).

---

[113] C.f.: (Guyer 1987, chapters 15 and 16); (Strawson 1966, 263). Whilst Guyer considers transcendental idealism to be 'harshly dogmatic' (Guyer 1987, 333), he takes Kant's overall project seriously, and is sensitive to how the three *Critiques* hang together overall (Guyer 2006).

[114] Noumena are characterised by Priest as "certain objects", which we have to be able to "fix on"; such a description implies a presupposition that the contents of a given thought must be definite or particular in some way.

4.3.2. Noumenal causation

The second major criticism highlights the similar difficulty of how the Noumenal should be able to cause, or give rise to, the phenomenal realm. Because causation exists only as a concept of the understanding, and is therefore only applicable to judgements and objects of phenomenal experience, we run into a very similar contradiction. By trying to claim a causal relationship between noumena (*qua* objects) and phenomena, we extend the application of causation beyond the phenomenal. If causation is in fact a category of the understanding, then any judgement of causality ought to be one in which the categories can be applied. But the noumena are supposedly those things which cannot be suitable for judgement or cognition. Causality is a notion supplied purely by the very act of cognition where the categories are applied for the representation of phenomenal objects; causation cannot be applied beyond phenomenal objects, but to assert that the Noumenal causes phenomena is to apply the categories beyond the phenomenal realm, and to characterise causation as something which may occur independently from cognition.

In light of passages such as the following, it is understandable that one may take Kant to be talking about two sets of objects:

> [It] follows naturally from the concept of an appearance in general that something must correspond to it which is not in itself appearance, for appearance can be nothing for itself and outside of our kind of representation; thus, if there is not to be a constant circle, the word "appearance" must already indicate a relation to something the immediate representation of which is, to be sure, sensible, but which in itself, without this constitution of our sensibility (on which the form of our intuition is grounded), must be something, i.e., an object independent of sensibility.
>
> (*CPR*, A251-2).

Here, one could take Kant to mean that for each object of appearance, there is a corresponding (and implicitly equivalent) object "in itself", implying that the Noumenal is a realm of such objects, and that some causal relationship does hold between the two realms. Such terminology introduces the notion of particulars within the phenomenal realm, and so (implicitly) the equally individuated particulars of the Noumenal.

The latter set of ideas, if taken at face value, certainly entail a contradiction. Talk of objects at all already commits us to saying something positive about the so-called contents of the Noumenal, as though it were some domain with members or components suitable for description. The contradiction arises because we cannot so much as distinguish individual objects without spatiality, and therefore, cannot do so without our forms of intuition; but Kant makes explicit the idea that things in themselves cannot be cognized via the sensibility.

The debate between the "Two-Aspect" and "Two-World" position does not appear to offer a means of rescuing the Noumenal from contradiction. The Two-World approach constitutes the view already described, whereby Kant posits two distinct domains of objects (a set of phenomenal objects and also a set of separate but corresponding noumenal objects). The Two-Aspect position amounts to the claim that Kant posits just one set of objects, but then two aspects or standpoints from which that set is considered.[115] Both positions, however, still rest on a construal in which things in themselves are taken to be objects, or to hold some relationship to objects.[116]

There is evidence in Kant's text which suggests something much like a Two-Aspect position, for instance, when Kant makes the point 'that the object should be taken in **a twofold meaning**' (*CPR*, Bxxvii). Similarly, Kant asserts that 'the same objects can be considered from two different sides' (ibid., Bxviii, f.), and also describes the Noumenal in the following way:

---

[115] Strawson advocates the Two-Aspect approach (1966, 250-254), as does Allison (2004, chapter 8). There is a tendency in contemporary literature towards favouring the Two-Aspects approach over the Two-Worlds approach (Guyer 1987, 334); (Van Cleve 1999, 7). In spite of this trend, others argue that the 'linguistic evidence' in Kant's writing does not point us unproblematically towards either position over the other (ibid., 145). For a critical comparison of the two positions, see: (Hanna 2001, 95-119); (Van Cleve 1999, 6-8 and 143-150).

[116] The very phrase "things in themselves" (plural) becomes unhelpful because, if we cannot know anything about the noumenal world, this would exclude our ability to enumerate or quantify any supposed entities in that realm (for instance, through positing plurality). Such an argument is implicit in Schopenhauer's deployment of the term 'thing-in-itself' (Schopenhauer 1859/1969, 4) where he continues to use Kant's overarching idea whilst refusing to adopt the implication of plurality.

> our understanding acquires a negative expansion, i.e., it is not limited by sensibility, but rather limits it by calling things in themselves (not considered as appearances) *noumena*. But it also immediately sets boundaries for itself, not cognizing these things through categories, hence merely thinking them under the name of an unknown something.
> (*CPR*, A256/B312).

When he refers to things in themselves "not considered as appearances", one might infer (especially in light of Bxxvii and Bxviii-xix, f., above) that Kant conceives of objects in general, along with two positions from which to view those objects, i.e., one in which they are considered in combination with, or subsumption under, the conditions of experience (phenomenal objects), and then one in which objects are considered "in themselves", separate from the conditions of experience. But even with the Two-Aspects approach, although we have stopped positing distinct noumena in a separate realm, we are still characterising the Noumenal with reference to some set of objects. Allison, for instance, defends the Noumenal as a boundary notion, under the Two-Aspects approach (2004, 56-8); even so, the focus upon objects is still retained by the nature of this position. It is therefore unclear what the Two-Aspect position has to contribute to the notion of the noumenal-phenomenal boundary, over and above its potential use as one particular way of unpacking that earlier stage of Kant's development of the noumenal-phenomenal boundary. Despite the outcome of the Two-Worlds/Two-Aspects debate, any proponent of the Noumenal in terms of some set of objects one way or another is, therefore, still faced with over-coming the difficulties outlined above.[117]

4.4. The noumenal-phenomenal boundary defended

4.4.1. The "Broad Reading"

Within the criticism, debate also surrounds the extent to which the various terms are co-extensive and Kant himself does seem to take two or more of these terms to be

[117] Some commentators reject both positions, on the basis that neither adequately addresses the problems articulated above (Guyer 1987, 334), nor provides an acceptable reading of Kant, even if Kant's textual references to a "twofold meaning" are nonetheless worth serious attention (Hanna 2001, 108-9).

interchangeable whereas, at other points, there appear to be distinctions.[118] Some commentaries have dedicated a lot of space to untangling the various ways in which Kant appears to be talking about objects.[119] Others acknowledge the difficulty of interpreting the *CPR*, due in no small part to the extended time-frame over which it was written, and the subsequent variations in the alternative readings available (Priest 2002, 73-4).[120] Whilst acknowledging the sensitivity needed, to tackle such difficulties, some still reject the notion of the Noumenal even in its negative construal.[121]

The Broader Reading I endorse, from which we arrive at the noumenal-phenomenal boundary, is the one advocated by Cassirer (1918/81), and also emphasised by Kemp Smith (1918/2003). Cassirer argues that:

> [i]f one approached the … concepts of the transcendental and of transcendental philosophy, as they appear in the beginning of the *Critique of Pure Reason*, with the idea that one is hitting upon ready-minted coins whose value is settled once and for all, then one must inevitably be perplexed by the further progress of the book.
>
> (Cassirer 1918/81, 143).

Kant's notions are best read as developing throughout the *CPR*, and then further still in the second and third *Critiques* (Kant 1788/2004; 1790/2000). The inherent concepts, therefore, are not pre-established and clarified but gradually unfold with the progression of Kant's writing. Consequently, we cannot simply look for a full and definitive explication of the various notions in their initial definitions in the text.

The emerging construal gives us licence to take the noumenal-phenomenal boundary as Kant's fully developed idea, over and above possible implications from earlier passages (for example, in 'On the ground of the distinction of all objects in

[118] For instance, Allison points out a potential distinction between the "thing in itself" and the "noumenon" (2004, 58).
[119] For a strong account of such subtleties (for example, of the relationship between the noumenon and the transcendental object in the A edition), see: (Allison 2004, chapter 3); (Kemp Smith 1918/2003, 408-14). C.f.: (Van Cleve 1999, chapter 10).
[120] Van Cleve concedes that the terms "noumenon" and "thing in itself" may or may not be coextensive or synonymous, depending on whether the negative or positive version is considered (Van Cleve 1999, 134), but then having acknowledged the distinction, he proceeds to use these 'as interchangeable terms', on the basis that Kant often does so (ibid., 134).
[121] C.f.: (Allison 2004, 50 and 57); (Van Cleve 1999, 135).

general into *phenomena* and *noumena*'; *CPR*, A235-60/B294-315) where Kant was 'not in a position to explain that ... [we can] distinguish between understanding … and a higher power to which he gives the title Reason, … [which generates] a unique concept, that of the unconditioned' (Kemp Smith 1918/2003, 414).

The idea that the notions Kant employs are not firmly established and fixed, in the first instances of their use, suggests a potential source for the identified contradictions: if we assume that the notions are fully developed at the outset, then we end up missing the full force of Kant's ideas. As Cassirer explains:

> [t]he concepts … are not a stable foundation for the movement of thought from its beginning to its end, but they evolve and are stabilized in the course of this very movement. Anyone who does not keep this tension in mind, anyone who believes that the meaning of a specific fundamental concept is exhausted with its initial definition and who tries to hold it to this meaning as something unchangeable, unaffected by the progress of thought, will go astray in his understanding of it.
>
> (Cassirer 1918/81, 142).

On such a reading, '[m]uch that in isolation appears contradictory is illuminated only when it is ... interpreted in its whole context' (ibid., 143). In other words, we need to understand the establishment of the noumenal-phenomenal boundary as a development or process occurring within the *CPR*, and approach any textual evidence accordingly. The Broader Reading not only illuminates the full notion of the noumenal-phenomenal boundary, but also highlights evidence of the beginnings of this idea even within the earlier passages (viewed retrospectively). Earlier passages alone do not supply the completed fleshed-out version of the noumenal-phenomenal boundary, but upon the assumption that the full construal eventually comes to light, then such earlier passages can be characterised as the first signs of germination, of ideas which are to develop properly in due course. I shall indicate some examples of these earlier references, where relevant.

Because of the gradual emergence of Kant's overall point, particular terms will inevitably take on different inflections, and hold different conceptual relations to one another, at different stages of the text. Whilst certain terms may legitimately create problems if only read within their immediate textual context, we can understand these difficulties not as mistakes or contradictions, but rather as the hallmarks of ideas which are still in development as Kant writes. The meanings in the earliest stages are superseded by the eventual emergence of the mature concepts.

The problem, then, is not that the various referent terms for the Noumenal must be untangled and assigned their correct fixed meanings, so as to see how each fixed notion relates to the others; neither is the problem a case of establishing whether the notions at hand are coextensive or interchangeable. What is important, instead, is the job of explicating and identifying the emerging breadth and depth of the final construal at which we arrive, namely the noumenal-phenomenal boundary.[122]

The interpretations which consider noumena-*qua*-objects give rise to some of the frequent objections outlined above. Such approaches, therefore, do not get us very far, whether or not the commentator acknowledges the subtler differences and shifts in meaning, or the negative construal. My argument is that, on the basis of the principle of charity, if the criticisms in question lead to the rejection of the notion of the Noumenal, and when a subtler, alternative reading is plausible and also prevents such criticisms, then readings of the former type have little to offer and it is entirely legitimate to favour the Broader Reading.[123]

Taking into account the time-frame over which Kant's critical philosophy was written, this Broader Reading is supported by the text to the extent that we can track the increasing clarity to, and development of, the noumenal-phenomenal boundary as a regulative boundary notion, as the text moves on. Kant, after all, wrote the *CPR* over a number of years, so it is highly conceivable that his concepts and ideas matured with time over that period, with ongoing revision. The development of the noumenal-phenomenal boundary, as a part of the 'genuinely Critical standpoint' (Kemp Smith 1918/2003, 414), is made manifest towards the end of the *CPR*, in the notion of the unconditioned. Such considerations render the reading plausible and,

[122] A particular meaning given to a term in earlier passages (for instance, in 'On the ground of the distinction of all objects in general into *phenomena* and *noumena*'; *CPR*, A235-60/B294-315), and its semantic relation to other descriptions of the Noumenal, is important only in its contribution to an understanding of the wider context in which the boundary notion gradually develops.
[123] For further scholarly evidence for this reading, see: (Cassirer 1918/81).

coupled with the fact that it avoids the respective criticisms, I propose that this Broader Reading (resulting in the full construal of the noumenal-phenomenal boundary) is the one to favour. If we assume that Kant's work and ideas are a completed and stable system from the outset, then we end up missing the full force of Kant's transcendental philosophy (Cassirer 1918/81, 142-3); (Kemp Smith 1918/2003, 520-1).

4.4.2. The noumenal-phenomenal boundary and the principle of Reason

The noumenal-phenomenal boundary, properly understood, amounts to a regulative boundary notion. Put another way, the regulative principle of Reason (illustrated in the discussions of the Ideas of Reason, and the Ideal, for example) is identical with the application of the noumenal-phenomenal boundary. In §4.4.2, I shall explain how the noumenal-phenomenal boundary is manifested by the principle of Reason; in the course of doing so, I shall provide further evidence which both supports the Broader Reading, and demonstrates the character of the noumenal-phenomenal boundary. The present section will, therefore, also provide the groundwork for my subsequent argument (in §4.4.3) that such a construal of the noumenal-phenomenal boundary withstands criticism.

The principle in question is precisely the regulative *a priori* notion of the noumenal-phenomenal boundary; it is the application of the noumenal-phenomenal boundary which is just the employment of the regulative *a priori* principle of Reason (although, I should emphasise that I am interested only in the underlying principle exemplified by, say, the Ideas of Reason, or the Ideal, rather than in their specific details). Some totality or "all-ness" of conditions implies the bounding or containment of the totality; in other words, it implies the unconditioned given as a regulative boundary notion. The way in which Reason features in the *CPR* overall is very complex; initially, for instance, the transcendental ideas of Reason are characterised as 'really ... nothing except the categories extended to the unconditioned' (*CPR*, A409/B436). As Kant works through the Antinomies and cosmological ideas, and onwards, we find that the ideas of Reason 'are still more remote from objective reality than **categories**' (ibid., A567/B595), and then 'something that seems even further removed from objective reality than the idea is ...

the **ideal**' (ibid., A568/B596).[124] The metaphysics of the Transcendental Dialectic is also not without difficulty.[125] As my ultimate goal is to explicate a naturalised regulative boundary, I do not commit to the various metaphysical consequences of the Ideas, principles and Ideal of Reason, and so I shall not go into detail about these concepts. The Ideas and the Ideal are relevant only in that they illustrate the underlying principle of Reason, which is just the application of the boundary Kant seeks to utilise, i.e., the noumenal-phenomenal boundary.

Upn the Broader Reading, the noumenal-phenomenal boundary is a limiting regulative boundary, posited as a negative notion. Whilst it makes possible the conditions of experience (and so has a negative role to play in connection with appearances), the noumenal-phenomenal boundary is not to do with the cause of representations, or the things which are to appear (behind or prior to the appearance); the noumenal-phenomenal boundary is the unconditioned, setting a limit via the notion of the totality of conditions. To posit the noumenal-phenomenal boundary is, therefore, just to speak of a negative regulative boundary, understood problematically, and not some positive domain, object, or set of objects; neither is the noumenal-phenomenal boundary constitutive, or something about which we can assert positive claims. The full character of the noumenal-phenomenal boundary is illuminated in Kant's principle of Reason (instantiated, for example, in the Ideas of Reason) where Reason demands the notion of a regulative unified totality.[126] The principle states that Reason cannot help but generate some notion of the unity of all conditions, as a totality and regulative boundary notion; in other words, the application of the principle is just the application of the noumenal-phenomenal boundary. The spelling out of the essence of this principle of Reason (the unconditioned in its regulative use) constitutes precisely that same argument given in §4.2.[127]

[124] There is an important difference, for example, between the '**regulative** principle of reason' (*CPR*, A509/B539), and 'the principle of absolute totality ... [as] a cosmological constitutive principle' (ibid., A506/B539).
[125] See, for example: (Kemp Smith 1918/2003, 478-521, especially 506-508).
[126] Whilst the Antinomies may be instructive, later passages, for instance, on the Ideal (*CPR*, A567-642/B595-670) or the 'Appendix' (ibid., A642-704/B670-732), can provide us with a better insight into the nature of Kant's unconditioned regulative boundary (Kemp Smith 1918/2003, 520-1).
[127] I refer to "principle"-singular to specifically indicate the principle underlying the regulative use of Reason, although Kant refers to various principles throughout the discussion of Reason.

The identity between the noumenal-phenomenal boundary, and the application of the principle of Reason, is evident in the persisting reference to a negative boundary notion, referred to as the unconditioned (in later and early passages), or as "noumenal objects" or "things in themselves" (in earlier passages). From the beginning, Kant introduces the term "the unconditioned" as some limit or totality of conditions: 'that which necessarily drives us to go beyond the boundaries of experience and all appearances is the **unconditioned,** which reason necessarily and with every right demands ... thereby demanding the series of conditions as something completed' (*CPR*, Bxx). Whatever is contrasted with appearance is precisely the earlier notion of the Noumenal, and so in this initial description of whatever-it-is that lies "beyond appearance", Kant directly identifies the unconditioned with the Noumenal. In light of the fact that it also lies at the heart of the principle of Reason in later passages, the unconditioned therefore refers to the boundary concept in both its fullest and earliest construals, and is ultimately bound up with the noumenal-phenomenal boundary.

The principle of Reason posits a boundary is which is something we can never arrive at, because according to 'the regulative principle of reason ... there can be encountered **no experience of an absolute boundary,** and hence no experience of a condition as one that is **absolutely unconditioned empirically**' (ibid., A517/B545). The application of the regulative principle of Reason:

> is only a **rule,** prescribing a regress in the series of conditions for given appearances, in which regress it is never allowed to stop with an absolutely unconditioned. Thus it is not a principle of the possibility of experience ... nor is it a **constitutive principle** of reason for extending the concept of a world of sense beyond all possible experience ... Hence I call it a **regulative** principle of reason
> (ibid., A508-9/B536-7).

The Ideas of Reason (for example) illustrate the application of the principle, via the notion of totality, whereby the unconditioned constitutes a boundary which regulates or guides our progress. Such a regulative function obtains even if such a totality is heuristic (as, indeed, it is) rather than constitutive or definitive.

In the noumenal-phenomenal boundary, the limit in question is the totality of all possibility of human cognition and experience. Were we to speak of the potential cognition of objects which lie outside of or beyond these conditions, we would be attempting to cognize something which is outside of experience, from within that experience. Our very ability to cognize objects of experience (suitable for judgement) is allowed only by virtue of these conditions; cognition of objects, taken independently from constitutive conditions, would necessarily demand the very same conditions we are attempting to surpass, and therefore, such a notion leads to contradiction. It is tantamount to trying to ascertain what it would be like for a human to experience what the world is like beyond or outside of human experience. Without experience, nothing is *like* anything at all. No such noumenal objects, therefore, can be posited, and Kant's notion of the Noumenal is to be understood only in the negative sense, amounting to a limiting and problematic boundary concept, namely, the noumenal-phenomenal boundary, according to which there is no contradiction.[128] The is problematic in that it is there purely to guide our conceptions of what the conditions of experience *cannot* give us; it presents not a positive asserted something, but rather serves to prevent that which cannot be given.

4.4.3. Different types of mental capabilities

By virtue of two particular features of Reason, the objections outlined in §4.3 lose their efficacy and hold. Such features amount, first of all, to the distinction between thought and cognition, and then secondly, to the focus upon a boundary notion (rather than upon objects, or a realm of objects), respectively. I shall address the former in the present section, and the latter in §4.4.4. A full examination of the faculty of Reason reveals that there are in fact two different types of mental activity, namely, "thought" and "cognition", which do not amount to the same thing; subsequently, claims about what we cannot cognize do not necessarily determine what we cannot think. It is entirely consistent to assert the impossibility of cognition of noumena (where cognition is the seat of our judgements of phenomenal experience) whilst also asserting the possibility of thinking of the noumenal, once we

[128] Such a construal is the reason why I have chosen to talk about the "noumenal-phenomenal boundary", as opposed to referring to the Noumenal and the phenomenal as though they are two distinct realms, between which there is some (as yet unnamed) divisive line, acting as the boundary.

recognise the two distinct capacities.[129] Similarly, the concepts of Reason are not identical with, nor reducible to, the concepts of the understanding; any causation given by the Noumenal will, therefore, not be the same type of concept as is found in the understanding.

The legitimacy of the negative boundary notion is founded on the distinction between the mental activities associated respectively with the understanding and Reason, and (similarly) the difference between concepts of Reason and the concepts of the understanding. Kant explains that '[t]he term "concept of reason," ... will not let itself be limited to experience' (*CPR*, A310/B367). Instead, '[c]oncepts of reason serve for **comprehension,** just as concepts of the understanding serve for **understanding**' (ibid., A311/B367). In other words, cognition is for the domain of the understanding, but "thought" is given to Reason, which mental capacity extends beyond the sort of cognition that yields judgements about, and representation of, objects of experience. Essentially, we have two different types of mental activity and two equally distinct, corresponding types of concept.[130]

The thought/cognition distinction is introduced early on, when Kant asserts that, regarding the Noumenal, we are 'not cognizing these things ... merely thinking them' (ibid., A256/B312). Kant still refers, here, to either cognizing an appearance via the application of the concepts, or to thinking something aside from appearance (whereby the focus upon appearance is upheld). But the two functions of understanding and Reason become more distinct as the *CPR* progresses, and the regulative function of Reason (in which talk of appearances drops out) is more thoroughly illuminated. In such developments, Kant makes explicit the idea that thinking of a notion of something is entirely distinct from having knowledge of it or making a judgement about it. Consequently, the Noumenal is not contradictory because we can think that there is the Noumenal, just as a problematic boundary, without knowing anything positive about it (the latter would constitute cognising it as an object of experience). No positive sense of the Noumenal is permitted and so in

[129] This needn't be a version of the Two-Aspects approach, precisely because the focus is not on some realm of objects, nor on properties assigned to (or perspectives towards) objects.
[130] Hanna makes the same point, arguing that whilst both distinct concepts (of two variants of causality) 'do share a single semantic core', they are at the same time 'sharply divergent in meaning, because they describe radically different sorts of things. Hence they do not intrinsically contradict one another' (Hanna 2001, 115). For a full account of his argument, see: (ibid., 113-119).

thinking the Noumenal, we are in no way trying to think the unthinkable, or know the unknowable.

Due to this thought/cognition distinction, the objection concerning Reason's application of the concept of causality also no longer stands, precisely because the concepts of Reason are quite distinct from those of the understanding. The criticisms of inherent contradiction within the Noumenal rest upon the definition of the notion, *qua* an object or set of objects, as that thing or things to which the categories of the understanding do not apply (or, as some set of objects which are the origin of appearances). But if thought is distinguished from cognition, then no attempt takes place to employ the categories where they may not be applied. The employment of Reason's concepts does not amount to the notion of our trying to extend cognition beyond its own capacity, as no concept of cognition is used. Such distinctions take out the force from the objections about Noumenal causation, and knowing the Noumenal. But more significant is the fact that the noumenal-phenomenal boundary amounts only to a negative regulative boundary, that in no way gives rise to the phenomenal, and that bears no relation to objects.

4.4.4. The "unconditioned" instead of objects

The very construal of a regulative and problematic boundary constitutes the second characteristic of Reason which resists the type of objections previously considered. The boundary notion moves us away completely from talking about objects, or any relations with objects. Given its strictly limiting boundary function, the noumenal-phenomenal boundary is not to do with appearance (in the constitutive sense), but is only related to the phenomenal world insofar as such a boundary regulates the possibility of the conditions of experience to begin with. The latter points, combined, demonstrate that we are not somehow trying to think beyond the capacity of thinking, or extend our use of the categories to cases where they necessarily cannot be applied.

As already explained, what is often overlooked by critics is the truly problematic status of the noumenal-phenomenal boundary. Kant's negative construal is sometimes characterised as an after-thought of sorts, posited as the result of Kant supposedly being ‘very uncomfortable’ (Priest 2002, 82) about the contradictions. The introduction of the negative construal supposedly only constitutes an attempt to try ‘to wriggle out of the contradiction’ (ibid., 82), at which attempt Kant is (apparently) unsuccessful (ibid., 82).[131] But Kant stipulates throughout that the Noumenal is ‘merely a **boundary concept** … and therefore only of negative use’ (*CPR*, A255/B310-1).

As a negative boundary, the noumenal-phenomenal boundary does not admit the opportunity for us to make judgements where we are not permitted to do so, let alone admit its own description in terms of objects. There is no positively asserted concept or entity at hand, with respect to which we may or may not be able to identify objects or assert propositions. So any criticism about the contradiction of our knowledge of the Noumenal just has no basis from which to take off. We may characterise the preoccupation with objects, or the mere possibility of objects, as just one early stage in the process of Kant’s development of thought about the Noumenal; this is a stage which is eventually set aside as Kant’s ideas mature, and the terminology of “objects” and appearances is subsequently dropped.

According to the Broad Reading, therefore, earlier descriptions of the Noumenal amount to only transitory stages of the process of conceptual development. Rather than taking such initial references as evidence for Kant’s final definition of the Noumenal, focus upon objects or appearance gives way to the construal of the regulative use of the unconditioned, i.e., the noumenal-phenomenal boundary. When Kant explains that ‘[i]f ... I suppose there to be things that are merely objects of the understanding and that, nevertheless can be given to an intuition, although not to sensible intuition ... then such things would be called *noumena*’ (ibid., A249) we should remember that this claim is taken from the A edition, and so we need not take this reference to “things” as the definitive and final description (whether such things seem to imply a separate set of objects, or a different aspect from which to view the same set of objects).

[131] The negative construal is deemed, by Priest, not to work because it still deals in ‘*things* about which we cannot judge [my italics]’ (Priest 2002, 82). It is a shame that, whilst Priest acknowledges Kant’s ‘changes of view’ (ibid., 83), he does not take such changes into account in order to develop a subtler picture of the Noumenal.

In some of the earlier passages, Kant also starts to emphasise the idea that 'the concept of a *noumenon*, taken merely problematically, remains not only admissible, but even unavoidable, as a concept setting limits to sensibility … [I]t is not a special **intelligible object** for our understanding' (*CPR*, A256/B311-2). Whilst we still find the limiting function explained in terms of things in themselves, or noumena, Kant explains that he is not actually talking about some object or set of objects. Debates about whether Kant is asserting a mere possibility or an actuality also become immaterial in the end, because the noumenal-phenomenal boundary is not a positive assertion of anything actual or possible: the boundary is problematic.

The point of the negative construal is, therefore, that there are no such things, precisely because the positing of noumenal objects is to over-extend the conditions for the possibility of experience (the over-extension of which is exactly what the boundary is there to prevent).[132] The noumenal-phenomenal boundary, therefore, is not do with appearances or representations of whatever-it-is that appears, because 'the distinction is no longer between representations and their noumenal causes, but between the limited and relative character of the entire world … and the unconditioned reality which Reason demands for its own satisfaction' (Kemp Smith 1918/2003, 416). No problems arise at all, of knowledge claims, of a judgement which is contradicted by its very assertion, or of "thinking beyond thinking".

Cassirer defends such a construal by arguing that the thing in itself gives rise not to a contradiction but, in fact, to a nothingness:

> A contradiction arises only where I combine two positive predicates that are antithetical into a single concept and hence posit them jointly. Here, though, I have not posited anything in general; I have merely cancelled out the

[132] We can distinguish between the positive (contradictory) notion of the noumenon, and the properly negative notion which is put to positive use. Under such a distinction, '[t]he class of positive noumena … are represented by what Kant calls "concepts of reason" or "ideas of pure reason" ... [a]nd, just as pure concepts of the understanding are meta-concepts, or second-order logical concepts for organizing first-order or empirical concepts, so ideas of reason are meta-meta-concepts, or third-order concepts whose function is to represent unrestricted extensions of pure concepts' (Hanna 2001,106). The negative regulative boundary, for which Reason has a positive use, is therefore not the same as the positive notion, which has been ruled out, which point Kant even indicates in the Preface to the B edition, where he describes the negative boundary as having a '**positive** utility' (*CPR*, Bxxv). Regarding such a distinction, see: (Cassirer 1918/81, 216-7); (Hanna 2001, 116-7). Cassirer and Hanna both point out that the full positive use of the boundary notion and of Reason (for instance, the full development of the causality of Reason) is found in the moral law and aesthetic judgement.

conditions known to me under which I can posit something. The result is thus not a contradiction but pure nothing

(Cassirer 1918/81, 213-4).

Were we to try to assert something about what experience of the world would be like independently of experience, then we would be asserting a contradiction; but it is perfectly acceptable to say that we cannot experience the world outside of, or independently to, experience. Again, we may distinguish between the notion of knowledge about the Noumenal (which is not possible), and being able to problematically (but legitimately) think some Noumenal nonetheless (Kemp Smith 1918/2003, 411). What Cassirer emphasises is that Kant does not even wish to positively assert the Noumenal hypothetically; the problematic noumenal-phenomenal boundary admits no positive assertion whatsoever (not even as a mere logical possibility).

Kant defines the notion of a problematic concept as one that 'contains no contradiction but that is also, as a boundary for given concepts, connected with other cognitions, the objective reality of which can in no way be cognized' (*CPR*, A254/B310). The focus is not on any actual something, but instead on how the noumenal-phenomenal boundary limits what we can cognize (whilst also having some association with that which we cannot cognize; it effectively straddles the "midway" between the conditions for cognition, and that which is unsuitable for cognition, rather than constituting some inaccessible realm or the cognitively impossible itself). The boundary understood problematically is not at all contradictory, because it just regulates what is possible, within the acknowledgement that there are limits. The noumenal-phenomenal boundary 'is necessary in order not to extend sensible intuition to things in themselves, and thus to limit the objective validity of sensible cognition' (ibid., A254/B310). The unconditioned therefore regulates the conditions of experience by bounding their scope (although not constitutively); in turn, this regulation both constrains but simultaneously makes possible such conditions in the first place. The conditioned demands and imposes limitation, by definition; in other words, in the absence of the notion of a limit, conditions must also be absent. The limiting role of the unconditioned as a boundary notion serves to both legitimise and make possible, but also to regulate and enclose the proper scope and extent of, the conditions of experience and judgement. The noumenal-phenomenal boundary is, therefore, associated with the phenomenal world of experience, but only to the extent that 'the **unconditioned** alone makes possible the totality of conditions, and conversely the totality of conditions is always itself unconditioned' (*CPR*, A322/B379).

Two points should be drawn from the latter characteristic or function. First of all, precisely because unconditioned is to be understood as a heuristic idea which is demanded for the possibility of conditions, the conditioned and unconditioned are necessarily interdependent. The unconditioned (i.e., the noumenal-phenomenal boundary) regulates the possibility of judgements, and is therefore necessary, even if it cannot be specifically cognized itself (Cassirer 1918/81, 353). Secondly, it is because of this same relationship that we are given a unity to our experience at all, via the cohesion of the totality. Conditions both entail and demand the notion of the unconditioned as a regulative boundary notion, and the boundary in turn provides that unity (through its containment of the totality) which makes possible the objectivity of judgements (under these conditions of experience). Such a notion of unity therefore frames (and is necessary for) any particular experience of the natural world; only from within our notion of a total unity, is any given experience or judgement supplied with the cohesion and unity necessary for lawful objectivity. The regulative unity, in other words, grounds the very possibility of objectivity, which aspect of the noumenal-phenomenal boundary is drawn out by taking further detail explicitly from later passages in the *CPR*.

4.4.5. The unity of the noumenal-phenomenal boundary

Having explained the connection between the principle of Reason and the noumenal-phenomenal boundary, and having demonstrated how this renders the considered criticisms ineffectual, in §4.4.5, I shall go into further detail about the character of the noumenal-phenomenal boundary, drawn from the principle of Reason, which becomes significant for the RB.

As demonstrated, the noumenal-phenomenal boundary (correctly construed) constitutes the proper instantiation of the principle of Reason, which is 'merely heuristic and **regulative**, taking care of nothing but the formal interest of reason'

(*CPR*, A616/B644). This regulating boundary is demanded by Reason, rather than having anything to do with "the world out there". This is precisely why the Ideas of pure Reason (as instantiations of Reason's principle):

> are never of constitutive use, so that concepts of certain objects would thereby be given ... On the contrary, however, they have an excellent and indispensably necessary regulative use, namely that of directing the understanding to a certain goal … although it is only an idea (*focus imaginarius*)—i.e., a point from which the concepts of the understanding do not really proceed, since it lies entirely outside the bounds of possible experience—nonetheless still serves to obtain for these concepts the greatest unity alongside the greatest extension.
> (ibid., A644/B672).

The principle of Reason may be explained as follows. For any totality, its wholeness and completion demands some notion of further unconditioned extension beyond the whole, against which its closure may be established (even if only as an idea). Such closure, in turn, demands a containment of the unified whole by a boundary. We cannot help but conceive of this enclosed totality; nonetheless, to actually experience the totality of experience we would necessarily have to assume some position from outside the bounds of experience itself, which is impossible. Whilst such a boundary from the notion of totality is absolutely demanded, it cannot by any means be constitutive, or definitive, or be thought of as empirically given: 'the absolutely unconditioned can never be met with in experience … But the duty of seeking it … is none the less prescribed' (Kemp Smith 1918/2003, 507).

Reason demands unity, therefore, in accordance with such a principle (in which the idea of the unconditioned necessarily follows from the conditioned); the demanded unity, in turn, regulates cognition:

> reason quite uniquely prescribes and seeks to bring about ... the **systematic** in cognition … This unity of reason always presupposes an idea, namely that of the form of a whole of cognition, which precedes the determinate cognition of the parts
> (*CPR*, A645/B673).

Such a totality or boundary must be regulative because it is no part of the natural world, but instead is generated by Reason; as such, 'cognition comes to be not merely a contingent aggregate but a system interconnected in accordance with necessary laws' (*CPR*, A645/B673). Whilst the unity of the principle of Reason is not constitutive of empirical objects, it is still absolutely necessary for the proper regulation of cognition; any notions 'of reason are not created by nature, rather we question nature according to these ideas, and we take our cognition to be defective as long as it is not adequate to them' (ibid., A645-6/B673-4).

Kant seeks to explain how objectivity is given to our judgements of the natural world, and an important part of this is played by the regulation of the limits of the conditions of such judgements. The unity, given by the notion of totality, provides the conditioned with the cohesion necessary for the proper application and objectivity of possible constitutive judgements of experience. This cohesion or uniformity, given to experience, allows for lawful generalisations, so that theoretical laws may be applied consistently with objectivity.

The unity, inherent in the regulative boundary notion, is also drawn out by Kant's aesthetic theory of the sublime (Kant 1790/2000);[133] it is by virtue of the sublime that we experience the underlying unity of Reason, and therefore, the use and nature of Reason is ultimately demonstrated through such sublime experiences (Cassirer 1918/81, 329-30); c.f.: (ibid., 298). The sublime is the aesthetic experience generated when we encounter something the greatness of which surpasses our faculty of understanding; unlike beauty, the sublime produces no feeling of pleasure but a feeling of being moved. The sublime produces in us no notion of the purposiveness of nature, but instead some experience which:

[133] Aesthetic judgement of beauty may also be relevant here; see: (Cassirer 1918/81, chapter 6). Kant's aesthetic theory is not from an interest in art *per se*, but from an examination of how the natural world appears to us to be lawfully arranged; the idea is that the lawful appearance of nature is found in the form of judgement itself (ibid., 296). Our judgement of purposiveness without end in nature, which constitutes the pleasure felt in beauty, means that we can understand the unity or lawfulness of nature as an aesthetic concern, because a connection is developed between the formal structure of theories and the aesthetics of those structures (for instance, symmetry). Other thinkers have also conceived of the structure within the exact sciences in terms of aesthetic values. For instance, our theoretical understanding is 'now no longer a question of the general idea of the mathematically simple natural law, but the definite concrete laws of nature themselves stand before us in their wonderfully transparent mathematical harmony … as the theoretical structure is completed' (Weyl 1932/2009, 59). This association between aesthetic quality and the cohesion of lawful explanation brings to the fore the huge significance of unity in scientific theory. For other examinations of the notion of beauty in science, see: (Weinberg 1993); (Zee 1986/2007).

> excites in us the feeling of the sublime … [which will] appear in its form to be contrapurposive for our power of judgement, unsuitable for our faculty of presentation, … doing violence to our imagination
> (Kant 1790/2000, 5: 245).

In other words, the magnitude of the experience defies our capacities for understanding, but because we are also aware of Reason's capacity to nonetheless think some infinite totality, we are made aware of the unifying force of Reason in its supersensible capacity. In other words, the thinking of a totality (of a "magnitude") 'indicates a faculty of the mind which surpasses every standard of sense' (ibid., 5: 254). Kant explains that:

> **even to be able to think** the given infinite without contradiction requires a faculty of mind that is itself supersensible. For it is only by means of this and its idea of a noumenon ... that the infinite of the sensible world is **completely** comprehended in the pure intellectual estimation of magnitude
> (ibid., 5: 254-5).

Because the sublime 'compels us to **think** nature in its totality, as the presentation of something supersensible' (ibid., 5: 268), we experience ourselves as creatures of Reason, and therefore, as being necessarily connected to the unconditioned or supersensible; 'in judging a thing to be sublime ... [the imagination] is related to reason, so as to evoke a harmony of the mind' (Cassirer 1918/81, 329). In the sublime, therefore, we fully appreciate the unity given to experience via the unconditioned.

The regulative boundary supplies us with the notion that our experience is necessarily unified, and as the unconditioned is provided as the corollary of any conditions, this regulating and unifying function also obtains for any equivalent naturalised notion of the unconditioned as a boundary to conditions. The noumenal-phenomenal boundary, therefore, is not only a regulative limit, but at the same time, it also amounts to the very unity within and throughout that bounded totality (and so, any one part of that totality), and by which the totality is given cohesion and closure. In other words, the regulative function is one which both bounds and unifies, and may be thought of as both a regulating boundary or a principle of unity.

4.5. The Regulative Boundary

4.5.1. The naturalised boundary

I have shown in §4.2 that the unconditioned follows from conditions in a naturalistic context. From the positing of conditions for scientific inquiry, provided by the constitutive framework, the RB follows as a boundary notion of totality or the unconditioned, i.e., as the ideal unity of completed total science. Having also defended the Broader Reading, I argued for the legitimacy of Kant's noumenal-phenomenal boundary as a boundary notion and as the application of the regulative principle of Reason. Now it remains to provide some detail on how the noumenal-phenomenal boundary is developed into a naturalised regulative boundary for scientific inquiry, namely, the RB.

The regulative ideal of the unity of science is not metaphysically grounded upon Kant's architectonic, and therefore commits to none of the metaphysical claims (aside from the minimal metaphysics involved in any modal claim about the necessity of a heuristic ideal). The RB is nonetheless epistemologically motivated. The demand comes, this time, from the commitment to naturalism itself: we may hope for a possibility of a completed science, but may in no way presuppose it or make any stipulations ahead of inquiry. So whilst the notion of the unconditioned follows necessarily from our notion that there are, in the very broadest sense, conditions for the possibility of scientific inquiry, we are not permitted to form a constitutive notion of such a boundary, as the possibility for the actual unification of science is at best a matter of further inquiry (if it is even possible at all). A distinction must, therefore, be recognised between the constitutive future project of unification of scientific domains, and the regulative notion of the unity of science. The unity or boundary notion indexes both the regulative ideal of a completed science, as well as the unification inherent within some completed science (and which is therefore implicit in any given stage of science, thought of as some step in the progress towards a completed science). In other words, just as the noumenal-phenomenal boundary indexes both the boundary for, and therefore unity throughout, the totality, so the RB indexes the regulative notion of a boundary for, and unity throughout, total science; a regulative boundary both completes as well as consists of the totality, whilst grounding the objectivity for and unification of the particulars within the boundary.

Because RKN does not commit to the concepts of the understanding, and because the latter determine the particular concepts and Ideas of Reason, no commitment is made to the underlying metaphysics of the Ideas and the Ideal. Within the Antinomies (for instance), we encounter a certain reflexivity of thought, which is not brought to the RB (the conditions for inquiry are not co-extensive with the conditions of all thought and experience, according to RKN). The potential difficulty involved in the reflexivity of the limits of all possible thought is that a total set of conditions cannot be one such condition itself (at least, not constitutively), otherwise it would have to contain itself as a member (and this is precisely why the noumenal-phenomenal boundary must be regulative only); in other words, the total set posited would go beyond its own limits. A thorough-going Kantian reading of the Antinomies, for instance, illustrates the reflexivity that gives rise to notions which appear to both complete and transcend the totality of the possibility of thought.[134] Because we are dealing with naturalistic inquiry, we are simply required to assume some sort of meta-scientific position in order to reflect on naturalistic conditions, and therefore, the issues of reflexivity do not obtain.[135] We have no need to make recourse to any kind of metaphysical commitment.

In addition to the sort of conditions discussed in chapter 3, there are basic cognitive and institutional conditions which must obtain for the possibility of scientific inquiry (c.f.: chapter 2, §2.5.2). We needn't know what these are in order to specify *that* they must be in place. As with the notion of the relativized *a priori* principles, we can understand a naturalised limit to the conditions for inquiry, instantiated in the notion of the completion of a unified science. The possibility of the human capacity for scientific inquiry is not restricted by our human perception of

[134] Whilst such reflexivity is tangential to my concern, the underlying issue can be mathematically addressed by an examination of infinity, especially by way of the ideas of Gödel and Cantor and their work on set theory and the incompleteness of arithmetic. See, for instance: (Gödel 1934/86; 1947/90; 1964/90); (Giaquinto 2002); (Smith 2007). For specific discussion of how the mathematical ideas apply to the problems articulated by Kant, see: (Priest 2002); (Moore 1990/2001, chapter 6). Both Moore and Priest emphasise the importance of Kant's ideas towards an understanding of infinity, and the credit due to Kant as the first to formulate the significant philosophical problem of infinity (Priest 2002, 74 and 100-1); (Moore 1990/2001, 86 and 93).
[135] Note that a meta-scientific position is no way *anti*-naturalistic.

the experienced natural world, and nor are the conditions in question those for the entirety of human thought or experience. The conditions for scientific inquiry, therefore, need not be supplied by one particular (or every) human mind, even though the conditions still depend upon human cognitive capabilities in some broad respects.[136] No metaphysical difficulty with thinking the limits of thought need arise, and therefore, the commitment to naturalism is not challenged by any metaphysical entities or doctrines.

4.5.2. The completion of science

Towards the end of the *CPR*, Kant describes the regulative use of the principle of Reason, using a spatial horizon as a metaphor for awareness of our own ignorance, or our particular stage of progress in discovery (*CPR*, A758-9/B786-7). This metaphor is extremely useful in demonstrating the application of the RB in a naturalistic context.

Consider the experience of standing on a flat plane, and viewing the horizon. This horizon seems to constitute our spatial limit, but if we walk further, the horizon shifts. We still have a notion of the “fixed” point of the horizon, but not as something we will actually reach: it is not constitutive but regulative. Our limiting horizon is a constant feature of our visual field and, therefore, of our progression. The regulative nature of the horizon gives us a very clear *notional* aim (we may still use the horizon as a frame of reference or guide for our direction) but without providing any actual spatially located goal (*qua* some point to which both the term “horizon”, and a specific fixed set of coordinate values, uniformly and consistently refer). Likewise, the heuristic notion of unity lends to any stage of progress the sort of cohesion which makes sense of our ever-accumulating progression of knowledge. To put it another way, we don’t characterise the aim of science as the intention to just move in any old direction; we take our aim to be progress (implicitly towards a continually greater and more unified body of knowledge). The goal of a completed

[136] For instance, the ‘free creations of the human mind’ (Einstein 1921a/82, 234) were necessary for Einstein’s interpretation of the role of the light principle within the transformation equations. C.f.: chapter 2, §2.5.2, chapter 3, §3.3.2 and §3.4.2, and §3.5, n.101.

science sets a heuristic aim by which progress is so much as understandable.[137] The boundary both necessarily limits, and enables or fuels, our inquiry. We cannot think of ourselves as cognitively unbounded, because:

> [o]ur reason is not like an indeterminably extended plane, the limits of which one can cognize only in general, but must rather be compared with a sphere, the radius of which can be found out from the curvature of an arc on its surface
>
> (*CPR*, A762/B790).

The sphere of the earth sets definite limits to the extent of our movement, so that we have a clear understanding *that* we are limited whilst also not allowing us to posit a definitive boundary within our surrounding spatial extension.

The notion of a unifying yet limiting boundary persists across scientific development and theory-change, precisely because of its regulative character.[138] According to Kant's metaphor, the more we discover/travel, the more we see that there is to discover/travel. Our capacity to travel further is limited, but only by a guiding rather than constitutive boundary, so that:

> [i]f I represent the surface of the earth (in accordance with sensible appearance) as a plate, I cannot know how far it extends. But experience teaches me this: that wherever I go, I always see a space around me in which I could proceed farther
>
> (ibid., A759/B787).

In other words, we can have the idea that our investigations are limited in principle, without making any attempts to stipulate a demarcation of such limits. In terms of naturalistic inquiry, therefore, we have the notion of completion against which we understand that there is still potential progress to be made; this idea guides us forward, towards the heuristic ideal of a whole and totally cohesive body of knowledge. This idealised boundary continues to regress, as we move forward but do not arrive at such a completion of science; but it also persistently obtains precisely because it is never met with in our inquiry. The regulative notion of completion

[137] Regarding the necessary objectivity of this unity, in Kantian terms, 'how could we treat diversity in nature as only disguised unity, if we were also free to regard that unity as contrary to the actual nature of the real?' (Kemp Smith 1918/2003, 547).

[138] Recall that the ideal notion of unity is entirely consistent with naturalism; c.f.: chapter 2, §2.3.2.

brings our acknowledgement of human limitations into line with our seemingly indefinite potential for scientific progress.

Not only does the RB persist across theory-change, but it is precisely because of the inherent unity given by the boundary that theoretical revolution is possible at all, and by which we may consequently make sense of the relativity of a given constitutive framework. The unity necessarily persists across theoretical developments, and it is only by the ideality of this enduring constant notion that any principle of inquiry can be relative (in other words, a totality is needed so as to provide the contrast or constant against which any varying notions are relative). This is, in short, precisely a description of Cassirer's regulative *a priori*, which affords the possibility of relativized *a priori* principles within a constitutive framework, according to particular stages of inquiry. That we can have relativized principles is only possible because they are relative to the regulative notion of unity or totality, which unity plays a permanent (and therefore "*a priori*") role, even in its regulative character, and which is demanded not by empirical data or a particular theory, but by an epistemological modal claim about science, in other words, by 'a characteristic function of thought' (Cassirer 1910/2003, 118).[139] This unity is therefore a heuristic ideal but, nonetheless, a notion demanded by our very conception of investigative progress. As such, the RB is precisely Cassirer's principle.

4.6. Conclusion

I have argued that Kant's noumenal-phenomenal boundary is legitimate and withstands the objections often levelled at the notion of the Noumenal; it constitutes a negative regulative boundary, the application of which is just that same application of the regulative *a priori* principle of Reason. I have, in addition, shown that the significant characteristics of the noumenal-phenomenal boundary are also those of the RB, and that the RB derives from both its similarity to the noumenal-phenomenal boundary and also from a naturalised argument concerning conditions. The RB, as

[139] Although the notion of the conditions for the possibility of science, *per se*, are not mind-dependent in the same way as Kant's conditions, the way in which we think of science in terms of a demand for a totality of scientific understanding is one example of a crucial way in which human reason plays a distinct role within the possibility of scientific inquiry. C.f.: chapter 5, especially §5.5.8 and §5.6.

Cassirer’s regulative *a priori* principle, is properly Kantian by virtue of its basis in both RKN and Kant’s noumenal-phenomenal boundary; furthermore it is a notion which falls entirely in line with naturalism. The RB will constitute a central part of the uses or applications for RKN, and such application will be the subject of the remaining chapters.

Chapter Five:
Problems, Mysteries and the Limits of Science

5.1. Introduction

In the first three chapters, I have defended RKN (Revised Kantian Naturalism), and its properly naturalistic character which retains certain significant features of Kant's transcendentalism, with regard to naturalistic inquiry. RKN provides an account of a constitutive framework, by which we may think about the conditions for the possibility of inquiry, and the RB (the Regulative Boundary) as a regulative boundary notion, or regulative principle of unity. As such, in chapters 5 and 6, I take any use of RKN or the RB to carry an implicit but significant Kantian characteristic (to the extent explained in chapter 2, §2.4).

In chapters 5 and 6, I shall explore particular applications for the RB within the areas of philosophy of cognition (or cognitive psychology) and the philosophy of science. The present chapter explores a particular connection between what is known about the mind, and the human cognitive capacity for scientific inquiry. The discussion revolves around problems and mysteries, and the notion of a problem-mystery distinction.

In the present chapter I shall consider McGinn's (1993) contention that consciousness must be mysterious, and Chomsky's (1988a; 2000) suggestion that the scientific capabilities of humans may be endogenously specifiable if we are able to establish a "Science Forming Faculty". Both suggestions involve an explicit conceptual differentiation between problems and mysteries (although the conceptual difference itself is not identical to a strong demarcation between the respective sets). I shall argue that, where their ideas variously imply a sharp and specifiable problem-mystery distinction, any stipulation of such sharp distinction is mistaken and not feasible. Indeed, both suggestions rely upon a distinction between problems and mysteries. I shall argue that, instead, the problem-mystery distinction should be properly construed as a regulative notion, which is brought to light by the RB.

Both the notion of the SFF and the "mysteriousness" of consciousness are ideas which perpetrate the stipulation of a constitutive problem-mystery distinction (or at least, may be read as doing so); nonetheless, both proposals are made in the name of naturalistic inquiry, and therefore warrant a full examination. Whilst the RB offers no cognitive abstract architecture (and to that extent does not match the purpose of the SFF), the RB nonetheless serves to emphasise and draw out the very legitimate motivations to which the SFF is Chomsky's answer. Put otherwise, the RB usefully illuminates that extent to which the SFF might remain a fruitful notion.

5.2. Problems and mysteries

5.2.1. Naturalism and its limits

The idea that humans have more to discover via scientific inquiry is uncontentious, as is the notion that humans are nonetheless limited in our capabilities. Similarly, we can acknowledge that we have more to learn specifically about the mind, whilst simultaneously conceding that our understanding of the mind must be limited in some sense. Indeed, both Chomsky (1993, 45; 2000, 74) and McGinn (1993, 4) explicitly promote the idea that there are undoubtedly questions which are entirely beyond our cognitive capacities, and such claims resonate strongly with Kant's famous remark to such an effect (*CPR* Avii). There is far less agreement about what is to follow from these ideas (for example, regarding the nature and demarcation of cognitive limits).

In chapter 2, I have indicated some of the reasons why the mind is sometimes taken to be not wholly naturalistically tractable (see especially §2.2), and some of the potentially philosophical concerns about inquiry into the mind (for instance, the issues surrounding the notion of distinct taxonomies for the domain of the mental).

As I have demonstrated, naturalism requires resistance to pessimism about progress (i.e., we should not refrain from inquiry on the basis of expected failure) alongside a humility towards our own epistemic and cognitive capabilities. We may accept that there may be some areas of the universe for which we are not capable of developing a scientific explanation (so long as we do not stipulate these areas in advance). In other words, a truly naturalist approach to mind and cognition requires a simultaneous investigative optimism and epistemic modesty; we must hope for progress and discovery, whilst acknowledging our limits and ignorance.

But in the attempt to uphold both epistemic modesty and investigative optimism, either attitude may be distorted into effectively anti-naturalistic positions, namely, investigative arrogance or dogmatic pessimism. The distortion of a naturalistic approach into such anti-naturalistic extremes is exemplified within two types of claim, in which implicit or overt attempts are made to demarcate a constitutive problem-mystery distinction. The apparent impossibility of answering certain questions might be mistaken as evidence of a mystery. On the other hand, hope for potential investigative progress in any area might turn into a stipulative prediction of certain success in that area, ahead of inquiry. In the former case, we mistake a constitutive stipulation about the domain of the naturalistically intractable with epistemic modesty; in the latter, such an assertion would over-extend investigative optimism in an unlicensed attempt to determine *a priori* the minimal parameters for possible inquiry.

Attaining an approach characterised by both epistemic modesty and investigative optimism requires a certain balance in methodological attitude. Such an attitude, in turn, demands that we refrain from positing a strongly demarcated problem-mystery distinction, whilst nonetheless acknowledging that some distinction must hold. My argument in this chapter is that the RB sets into relief the danger of both of the latter types of temptations, whilst guiding our inquiry in a way which uniquely combines epistemic modesty and investigative optimism.

The problem-mystery distinction provides the notion of some division between those areas in which we are capable of making epistemological progress, and those which are inherently beyond the capacity of human understanding. Some distinction, therefore, must obtain between problems and mysteries; acknowledging such a boundary is not the same as identifying it definitively. In other words, understanding that there is a distinction is not to be conflated with being able to demarcate a constitutive division.

5.2.2. Problems and mysteries defined

Let us understand a problem-mystery distinction as that division between the types of problems humans are capable of tackling, and those which are in principle entirely beyond us. Each issue of inquiry is either a problem or a mystery, by definition, where these two categories are mutually exclusive, and exhaust the full set of potential issues. Prior to identifying a given question or issue as something which is either within our grasp, or insoluble, we may think of the set of issues which are yet to be established as either one or the other; let us call these problem/mysteries (i.e., the set of all items which are either a problem or mystery exclusively, but which have yet to be assigned to either category).

The very idea of a problem-mystery distinction entails no claim about whether such a distinction is strong or weak, and the notion of the distinction is therefore not problematic in itself. The distinction has, however, been used to try to discern those areas that are beyond epistemological access to humans, and has also featured in predictions about those areas in which we may expect to make progress, in the positing of a strong problem-mystery distinction. Chomsky's proposal of a Science Forming Faculty or "SFF" offers a naturalistic solution to the possibility of a clearly demarcated problem-mystery distinction, by means of a faculty boundary, from which basis we might try to discern those areas in which humans are potentially capable of scientific progress. At the other end of the spectrum, McGinn proposes that certain philosophical positions, such as the issue of consciousness,[140] exhibit the qualitative features necessary for them to be deemed mysteries.

[140] The set of issues he takes to be mysteries includes most philosophical questions, for instance, the mind-body problem, free will, meaning, and the notion of the self (McGinn 1993). Specifically with regard for McGinn's assertion that consciousness must be mysterious, compare the remarks in chapter 2, §2.2.1, n.19.

The difficulties of the SFF and of McGinn's proposals may, if we wish, be cleared up independently from the RB and RKN. What I seek to show instead is that the properly naturalistic argument for the extent to which we may posit a problem-mystery distinction is instantiated by the RB. In other words, the RB supplies us with a problem-mystery distinction which is consistent with naturalism and which achieves the appropriate balance between investigative optimism and epistemic modesty. In turn, such a balance is in fact integral to Chomsky's own attitude. Although the RB does not supply any faculty architecture of the mind, it usefully brings to light the same methodological commitments with which Chomsky posits the SFF in the first place. As a further consequence, the rejection of the notion of the mysteriousness of consciousness sets into relief some important points about our inquiry into the cognitive capacities involved in the very undertaking of scientific practice and theorising.

We can take problems to be questions (or difficulties) that humans are potentially capable of answering (or resolving), in principle; our cognitive capacities are suited to tackling such questions, in other words. Mysteries, on the other hand, are by definition beyond the cognitive capability of humans (Chomsky 1988a, 155-9; 1993, 45). Regarding our cognitive abilities, the endowment of any capability, skill or capacity necessarily restricts the set of other possible capabilities, given that the conditions required (for the use of the skills in question) both enable and limit simultaneously. The definitions of both problems and mysteries rest upon modal claims about the human potential for understanding, given by our cognitive constraints and abilities. Problems are potentially open to solution, for humans, whether or not we arrive at the solution (and whether or not we are so much as aware of the relevant cognitive capacity); mysteries, on the other hand, 'are insoluble, inexplicable in principle. Unlike problems which may contingently evade resolution, mysteries lie beyond our understanding' (Collins 2002, 126). Mysteries, therefore, are not merely those questions to which we do not yet have an answer.

Chomsky brings out this distinction in a useful way. We may understand mysteries in a contingent manner, where "mystery" indexes some given problem/mystery for which we have not yet found a solution (so it would be "mysterious" to that extent), but which may nonetheless become surmountable with further time and inquiry; but a more absolute sense of mystery is also given, whereby such issues are just beyond our abilities in principle (Chomsky 1975, 138). For

> [a]ny organism … we can identify a category of "problem situations" in which it might find itself … Some problem situations fall within the animal's cognitive capacities, others not. Let us call these "problems" and "mysteries," respectively. The concepts are relative to an organism: what is a mystery for a rat might be only a problem for a monkey, and conversely ... The distinctions need not be absolute, but they can hardly fail to be real.
> (Chomsky 1993, 44-5).

I shall adopt the non-contingent use of the term "mystery".

What counts as a mystery is species-relative (Chomsky 2000, 107). We are given the cognitive tools to make sense of only a finite range of concepts, and consequently, the notion of difficulty, within a given area, is just a judgement relative to this initial cognitive groundwork with which we are equipped. Other organisms will have different cognitive set-ups, and subsequently a different set of domains in which they have sufficient cognitive competence. A comparison between the respective capabilities of rats and humans, for certain types of mental tasks, illustrates the present point. Rats prove to have maze-solving abilities, for certain maze-types, which exceed the respective average human capacities for problem-solving when faced with the same type of maze (Chomsky 1975, 159; 1991b, 41; 1993, 45). Rats, however, will not possess the same capacities in areas in which humans excel.

Having provided a brief over-view of problems and mysteries, the demarcation of problems and mysteries and of the extent to which claims about either one are permitted by naturalism, I shall consider two naturalistic proposals for a stronger claim about some problem-mystery distinction.

5.3. Is consciousness mysterious?

McGinn's claim, that consciousness must be mysterious (1991; 1993; 2004), is grounded upon an inherent epistemic modesty; according to McGinn, it would be ‘deplorably anthropocentric to insist’ that we are capable of understanding absolutely all of reality (McGinn 1991, 22). McGinn explicitly commits to a naturalist or realist position (ibid., 6, 21-2 and 91); (McGinn 1993, 5). Working with a definition of mysteries much alike to Chomsky’s definitions (McGinn 2004, 64),[141] McGinn proposes that, according to a naturalistic understanding of human beings, it is inevitable that our cognitive capacities should be limited. Humans cannot be cognitively endowed with the ability to solve every problem/mystery we encounter (McGinn 1993, 4), and given that we are but one part of the natural world, it is unlikely that we have been given the cognitive skills necessary to understand the entirety of that natural world. In other words, ‘[t]he natural world can transcend our knowledge of it precisely because our knowledge is a natural fact about us, in relation to that world’ (ibid., 5).

For any given system (such as a cognitive system), its constraints necessarily preclude it from producing a full description of the totality and limits of its own capacities, from outside of that limit; in the case of consciousness, we are therefore unable to stipulate our own cognitive limits from within the bounds of those limits (because of our lack of knowledge, and because of those very same limits). The question of what it would be like to experience the world “beyond experience” is, to be sure, nonsensical (c.f.: chapter 4). McGinn asserts that for humans to think about the mind from a perspective entirely outside of the mind is equally nonsensical. In such observations, McGinn therefore concludes that in order to respect our inherent epistemic limits, we must recognise this property of thought (McGinn 1991, 21; 1993, 3-6).[142]

More specifically, according to McGinn, the first-person properties of consciousness just do not admit of the theoretical generalisation which is achieved

[141] McGinn even cites Chomsky’s definitions explicitly; c.f.: (McGinn 1993, 86). The quote of Chomsky’s, which McGinn supplies, is described as an instance of Chomsky’s supposed commitment to the inherent mystery of particular issues. I suggest, however, that in cases where Chomsky identifies the possibility of a mystery, say, in the potential mysteriousness of free will, or the creativity of language, Chomsky offers a speculation which he would happily revise in the face of legitimate investigative results (should they become available), rather than an *a priori* commitment to inherent mystery. Chomsky provides ‘no more than a guess’ that free will is mysterious (Chomsky 1988b, 415), and elsewhere, when he claims that linguistic creativity ‘remains as mysterious to us as it was to [Cartesians]’ (Chomsky 2000, 17), he uses “mysterious” merely to refer to those cases in which no solution is found.

[142] McGinn compares his idea to the arguments put forward by Nagel (1986/89, chapter 6).

within scientific explanation (McGinn 1991, 21-2). The information within first-person conscious experience, precisely because of its subjectivity, cannot be transferred in the way that information about other phenomena may be transferred (McGinn 1993, 38-9); c.f.: (McGinn 1991, 29 and 100-1; 2004, chapters 1-4). As soon as it becomes third-person transferable, the information no longer carries the distinctive first-person quality. For other scientifically tractable issues, McGinn argues, information about the phenomena is suitable for the formulation of law-like generalisations by virtue of the cognitive abilities that allow us to generate such theories, and transfer such information. Such a reasoning capacity McGinn calls 'CALM … [or] "combinatorial atomism with lawlike mappings" … [which is] a certain mode of thought, suited to certain subject-matters' (McGinn 1993, 18). McGinn's conclusion is that the phenomenon of consciousness permits no such explanation which may be characterised according to the CALM theory.[143] Subsequently, McGinn claims, we are just not set up cognitively to deal with the sorts of philosophical questions that we are prone to ask. He acknowledges that 'historical failure is suggestive, but scarcely conclusive' (McGinn 1991, 7) as a criterion for demarcating instances of mystery, but argues instead on the basis of inherent characteristics of the mind that consciousness may be diagnosed as a mystery. In other words, given the manner in which problems *are* solved (i.e., by CALM methods), consciousness must be an insoluble issue.

McGinn's proposal constitutes a naturalistic attempt to dissolve those philosophical questions which do not indicate fruitful paths of inquiry. Guiding philosophical inquiry away from dead ends is certainly an important regulative task, and one may compare McGinn's insistence about the lack of solubility of philosophical problems with Kant's famous claim that:

> [h]uman reason has the peculiar fate … that it is burdened with questions which it cannot dismiss, since they are given to it as problems by the nature of reason itself, but which it also cannot answer, since they transcend every capacity of human reason.
> (*CPR*, Avii).

[143] McGinn does not suggest what the exact details of CALM should amount to, beyond such a definition (McGinn 1993, 18-9).

There is much to be said for philosophy (an example of which is found in Kant's work) which highlights the illusory nature of certain metaphysical questions. In addition to such an aim, McGinn's inquiry appears to proceed from a position of naturalistic modesty. Consequently, his proposal about the possibility of a clear yet naturalistic stipulation of mysteries may appear, on the face of it, to be a plausible thesis. Before assessing this possibility, I shall turn to Chomsky's proposal of a SFF.

5.4. Cognitive capacities for scientific thought

5.4.1. A naturalistic answer to the problem-mystery distinction

Chomsky suggests that there may be a specific faculty dedicated to scientific problem-solving, namely, a "Science Forming Faculty" (SFF). In certain instances, Chomsky discusses the possibility of a SFF as a an explanation for scientific theoretical convergence and progress (Chomsky 1971, 45; 1975, 24-6; 1988a, 157-8; 1993, 45). At other points, the SFF is suggested explicitly as a means by which we may be able to achieve a clearer notion of a problem-mystery distinction (Chomsky 1975, 155-6; 1988a, 156-9; 1993, 44-5; 2000, 22 and 82-3). I shall be concerned with the latter set of instances, but in both cases, the notion of an SFF is supplied upon the grounds that human ignorance must be, to some extent, hardwired into our cognitive architecture. In other words, the motivating attitude is one of naturalistic epistemic modesty.[144]

At different points, a stronger or weaker notion of the SFF is described; in all cases, however, the idea follows on from Chomsky's naturalistic commitments, according to which we should be able to inquire into the mind just as we would start out in any other relatively new area of inquiry. The very structure of the mind provides us with our cognitive capabilities, and in doing so, simultaneously sets our cognitive limits (Chomsky 1975, 25-6). Any biological system works by virtue of the structural features which enable its particular capabilities, whilst imposing conditions that render it limited. For instance, a mammalian respiratory system

[144] Bilgrami and Rovane (2005) emphasise the modesty inherent throughout Chomsky's work.

facilitates the extraction of oxygen from air; as a result, such respiratory systems do not provide the mammal with a means by which to extract oxygen from water (and so the particular workings of respiratory organs are limited). Such a respiratory system also imposes minimal constraints upon other features of the animal's survival; for example, mammals do not thrive by remaining in water without additional breathing apparatus (Bilgrami and Rovane 2005, 196). The features which allow the respiratory system to work also prevent it from working in other alternative ways. If we are to consider the mind naturalistically, then we may expect to identify for the mind equivalent basic systemic traits, of the types that are identifiable for other biological organs. Therefore, whatever cognitive structures constitute a part of our human biological endowment, such structures will provide us with both mental capacities as well as limits, where fairly specified demarcation of such limits might be expected (i.e., closure is given to the system via determinate structurally specified limits).

Chomsky explicitly endorses the idea that we may study the language faculty as 'a particular component of the human mind' (Chomsky 1986, 3); c.f.: (Chomsky 1988a, 7; 2000, 9). As such, the language faculty constitutes one of the clearer cases of faculty architecture and Chomsky frequently points out that there is little reason to expect the rest of the mind to rely upon general purpose mechanisms;[145] instead, we can expect that other cognitive capacities, such as our competence in scientific thought, may turn out to be endogenously determined cognitive systems (Chomsky 1971, 20; 1991b, 51). For example:

> the language faculty incorporates quite specific principles that lie well beyond any "general learning mechanisms," and that there is good reason to suppose that it is *only one of a number of such special faculties of the mind*. [My italics.] It is, in fact, doubtful that any "general learning mechanisms," if they exist, play a major part of our systems of knowledge and belief about the world in which we live—our cognitive systems.
> (Chomsky 1988a, 47-8).

[145] For more on inquiry into the language faculty, see: (Chomsky 2000, chapter 1). For further detail on the language faculty generally, and the methodological underpinnings of investigating an aspect of the mind, and as a topic for naturalistic inquiry, and the relevant methodological considerations, see for instance: (Chomsky 1975, chapter 1; 1980/2005, chapter 1; 1988a, 7-8; 1991a; 2000, chapter 4). See also: (Collins 2004; 2008; 2010).

Given Chomsky's commitment to our epistemic and cognitive limits, along with his assertion that human cognition looks as though it is neither domain-general nor non-modular, it is reasonable to make an inference to the notion that scientific thought is at least likely to be faculty-based. In the context of these ideas, it is possible to present the suggestion of a SFF as a loosely formulated *reductio ad absurdum* argument: if we had no specific endogenous closure then we would be omniscient; but we are by no means omniscient and so we must have structurally demarcated cognitive capacities. Chomsky may be thought to offer such an implicit argument (Collins 2002, 130), though the idea is consistently presented as a suggestion, rather than an *a priori* stipulation or empirical claim, and often just as a speculation. At places, Chomsky describes the positing of the SFF as merely 'dignify[ing] ignorance with a title' (Chomsky 1993, 35); c.f.: (Chomsky 2000, 22). In any case, whether he offers it as an argument or not is not central to my discussion. Often, such suggestions take the form of purely hypothetical proposals for a certain aspect of the mind (Chomsky 1988, 156), in which Chomsky makes clear that the notion 'is an open empirical question, and [that] no dogmatism is in order' (1993, 35).

Chomsky still proposes a fairly robust notion of this faculty, in places. Chomsky explains that the distinction between problems and mysteries 'need not be sharp, though we certainly expect it to exist' (2000, 83). But whilst this implies a weak notion of problem-mystery distinction, Chomsky goes on to assert that the SFF facilitates a way of determining the type of problem/mysteries which are within the cognitive reach of humans, because '*problems* … [will] fall within its range, and *mysteries* … [will] not' and as such, the 'successful natural sciences … fall within the intersection of the scope of SFF and the natural world … [where such] intersection is a chance product of human nature' (Chomsky 2000, 83); c.f.: (Chomsky 1975, 24-5). The specification of a distinct faculty implies that the SFF indexes some stronger notion than merely an acknowledgment that some problem/mysteries will be mysteries. Chomsky seems to want to say 'not merely that we are *epistemically* bounded … [but] rather, that such a boundary is endogenously determined to a specifiable degree' (Collins 2002, 127). In other words, the SFF amounts to a naturalistic means by which to discern the specifically demarcated problem-mystery distinction.

5.4.2. The similarities with the Language Faculty

In order to assess the notion of the SFF, some detail of the language faculty (with which it is compared), will be helpful.[146] In Chomsky's investigations into language, *qua* investigation into one aspect of the mind, he posits the Language Faculty (LF)[147] which may be understood as 'a "language organ" in the sense in which scientists speak of the visual system, or immune system … Understood in this way, an organ … is a subsystem of a more complex structure' (Chomsky 2000, 4). The language organ has its initial state (as it is in a human being at birth) and its developed state after exposure to experience. We might think of the initial state as that element of cognitive architecture with which all humans are endowed, as standard; in other words, the 'initial state [is] determined by biological endowment … [and as] such states are so similar across the species … we can reasonably abstract to *the* initial state of the language faculty, a common human possession' (ibid., 77-8).[148] The developed or assumed state may be taken as the stage at which a given human has acquired a particular language. So the LF is that piece of abstract cognitive architecture, in other words, some structure which captures the relevant systematic form on a functionally descriptive level, without commitment to the physical realisation; understood in such an abstract way, the LF provides the relevant structure and processes necessary for us to acquire and use a syntactically well-formed language with that data.[149] The particular experiences of an individual determine which specific language they learn, but the uniform internal architecture is necessary in order to take the input and produce the output of some language.

---

[146] I cannot give a detailed account of what a faculty should amount to, and assess the SFF upon that basis. But for such an account, see: (Collins 2002).

[147] Chomsky points out that the term "faculty" can relate to 'two different components: a "cognitive system" that stores information in some manner, and performance systems that make use of this information' (Chomsky 2000, 117). He goes on to clarify that such performance systems are those which 'access a common body of information … [and] can be selectively impaired, even severely so, while the cognitive system remains intact' (ibid., 117). For a thorough and informative explanation of both Chomsky's and Fodor's construals of "faculty", and the salient differences, see: (Collins 2004).

[148] C.f.: (Chomsky 2000, 4).

[149] The universally endowed functional capacities or structures may be thought of as a 'theory of human I-languages' (Chomsky 2000, 22). C.f.: (Chomsky 1965, 4; 1986, 3 and 22); (Collins 2004, 507).

The difference between Chomsky's notion of a faculty (interchangeable, in his usage, with "module"; Collins 2004, 504), and Fodor's conception of modules or input/output systems, is significantly complex and a full exegesis is not possible here.[150] Nonetheless, we can understand Chomsky's language faculty neither as a physical causal mechanism, nor an epistemological thesis about our grasp of language; rather, the LF may be taken as a device:

> The language faculty is a function in intension whose specification describes an aspect of the human brain. The function is from selections from a lexicon to infinite pairs of structures … The convergence of the pairs internal to the faculty accounts for the robust sound/meaning association upon which our linguistic performance is based.
>
> (ibid., 507).

We must be careful to note that such a definition does not commit to any sort of specification about how the faculty or its functions are realised, precisely because the respective functions are intensional; a description of the function provides detail of the computation (independently from how such computations are physically realised), which in turn generates the observed phenomena of linguistic output of pairings between sound and meaning. So, 'we want a function that produces the observed systematic and highly specific structures that are realised by meaning/sound pairings' (ibid., 509). The notion of Chomsky's LF must also be distinguished from general characteristics of faculties, which are definitive of faculties *per se*.[151]

Whilst we should avoid using the language faculty as a rigid analogy for the common properties and characteristics which hold across all faculties (Collins 2002, 139), Chomsky asserts that enough similarity obtains for the comparison to be instructive. Any faculty, for example, should be 'capable of a high-level of achievement in specific domains, and correspondingly unable to deal with problems that lie outside them … [and] we should expect that to be true of all our faculties' (Chomsky 2000, 121). If we take such a description to be representative of the SFF,

[150] Collins (2004), however, provides a very thorough and informative exploration.
[151] For details, see: (Collins 2002; 2004). On the distinction between Chomsky's faculties and Fodor's modules, see: (Chomsky 1986, 14, n.10; 1991a, 19).

then the SFF is characterised as a reasonably robust notion; i.e., it may be taken as a thesis about the structure of the mind, such that the SFF indexes something more specific than merely the idea that particular (if as yet unspecified) cognitive skills or mental capacities contribute to scientific inquiry and theorisation.

Chomsky speculates that there may be a faculty of the mind, very roughly analogous to the language faculty (insofar as faculties resemble one another), which performs the cognitive functions necessary for scientific thought and inquiry. The idea is that '[t]here would be problems in domains where admissible (or readily accessible) hypotheses are close to correct, and mysteries elsewhere' (Chomsky 1975, 156). Furthermore, '[t]he human science-forming capacity, like other biological systems, has its scope and limits, as a matter of necessity. We can be confident that some problems will lie beyond the limits' (Chomsky 1988a, 158). Chomsky makes clear that the SFF does not determine our understanding of life and the world *overall*: some problems will be best approached via other methods. The SFF 'is only one facet of our mental endowment. We use it where we can but are not restricted to it, fortunately' (ibid., 159); even so, the SFF 'must ... sharply constrain the class of humanly accessible sciences' (Chomsky 1975, 25).

If we consider the strong construal of the SFF, we have a notion given upon the back-drop of current scientific work within a relevant area, based on naturalistic commitments and epistemic modesty. Described as such, the SFF appears to supply us with a naturalistic means of distinguishing between problems and mysteries. The SFF preserves a strong epistemic modesty, and follows from a naturalistic hope for the scientific tractability of certain features of the mind. It appears, under such considerations, as though the SFF may be a perfectly reasonable suggestion.

5.5. The very notion of a sharp problem-mystery distinction

5.5.1. The impossibility of a strong demarcation

In the present section I shall provide an argument for why it is that we cannot, by definition, constitutively posit a strong demarcation between problems and mysteries. Because of our definitive lack of knowledge upon encountering a mystery, or an unsolved problem, we are incapable of distinguishing between a problem or a mystery whenever we encounter a problem/mystery (i.e., prior to any potential solution or awareness of a potential solution). The argument for this claim runs accordingly:[152]

1. A mystery, by definition, has no solution; as its lack of solution is inherent, we are frequently unable to prove that something is a mystery. By and large, the mystery will merely remain thus far unsolved (and lack of solution to a problem/mystery, whether contingent or inherent, is not qualitatively equivalent to the closure given by the discovery of a solution).
2. From 1, if some issue remains unresolved, it might be a mystery.
3. A problem/mystery is identifiable as a problem only by the discovery of its solution; in the absence of solution, such proof is not possible.
4. From 2 and 3, lack of solution is characteristic of both problems and mysteries.
5. From 1, and 4, no definitive characteristic for the distinction is possible, between unsolved problems and mysteries.
6. From 5, because solved problems only make up part of the set of all problems, no distinction is ever possible between the set of all problems and the set of all mysteries; no constitutive boundary may be discerned between problems and mysteries.

5.5.2. Lack of solution for problem/mysteries

Premise one follows from the definition of mysteries, but the nature of the inherent lack of solution for mysteries (and subsequent lack of closure) warrants some further detail. Premise three also requires further explanation. The notions, that only problems may be positively distinguished from problem/mysteries, and that mysteries appear to lack some significant equivalent means of definitive proof, may be explained with reference to the relevant characteristics of an unsolved problem/mystery; I shall provide such an explanation in the remainder of this section. I shall also consider and dismantle potential objections to the notion that one

[152] I follow the argument given in (Collins 2002).

may only identify a problem via its solution; such objections concern the instance of wrongly-formed questions, or of persistent failure to make progress with a problem/mystery.

To know for certain that a given problem/mystery is a problem (i.e. potentially solvable), we must have arrived at such a solution; until we have done so we can rule out neither possibility, of its being an as-yet-unsolved problem, and of its being mysterious, because both mysteries and unsolved problems will be, by definition, unsolved. For problems, the lack of solution is temporary or contingent; for mysteries, it is permanent and definitive. Solution is not a possibility, in other words. The distinction, however, between principled and contingent lack of solution, is not something we may identify within the lack of solution itself, in particular cases.[153] Therefore no amount of information about any given area (which remains open to discovery, prior to any solution) is enough for us to make the distinction one way or another.

Persistent lack of success is possible for both problems and mysteries. Our inference to a best explanation that something is “probably a problem” (if indeed this appears to be the best inference available) may be a useful and rational basis upon which to make a practical decision about the continuation of inquiry, but it does not constitute evidence that we are definitely dealing with one or the other. In the face of a perception that we’ve reached a dead end, or equally, that a solution seems to be “just around the corner”, the issue could still perfectly legitimately turn out to be a soluble problem in the former case, or a mystery in the latter.

At some point, many people are likely to believe that the chances of arriving at a solution (in the course of some investigation) are too slim to make it worth the dedication of continued time and effort to the problem/mysteries. Ceasing inquiry would seem rational, but such rationality should not be equated with evidence that

[153] Nothing about a lack of information tells us anything about the modality of our capacity to receive such information; the absence of the answer to a problem/mystery, in other words, does not demonstrate whether our understanding of such an answer is possible or impossible, just by our having not yet found it.

the problem/mystery at hand is a mystery.[154] The point at which we move on from the problem/mystery must be a judgement call, on the basis of some set of criteria, but not upon any epistemic proof about the identity of a problem/mystery as either a problem or a mystery, specifically.[155] We may certainly question the extent to which a given solution or theory ever really answers a corresponding question, given the possibility of future revision; subsequently, one might wish to question whether we ever really know we are dealing with a problem.[156] Nonetheless, we may still think of the distinction between a problem and a mystery in principle. The issue of whether or not we know that a problem is a problem becomes a part of a separate issue about epistemic certainty in general, and in any case, scepticism towards our knowledge of problems *qua* problems would still render it impossible to identify either problems or mysteries from lack of success.

5.5.3. The wrong questions

In a very similar way to the case of lack of success, a mistake in the framing of a problem is something which could occur for both a mystery and a problem. As such, any mistake in the formulation of a question (or suspicion of such a mistake)[157] gives us no indication as to whether or not we are dealing with a problem or a mystery. Having attained the right or wrong question proves nothing about the status of the problem/mystery.

---

[154] Consider, for instance, the cases where alternative theories are in competition, and one is eventually chosen over another. Any entities posited by the rejected theory (for instance, in the aether-theory which was displaced by SR) are not taken to be mysterious in any way.

[155] The reasons why a scientist might judge that a hypothesis should be abandoned, and that they had better move on to a different investigative question, raise issues which are closely linked to the notion of acceptance of a theory (whether on the basis that the theory must be true, or on the anti-realist notion that the theory is empirically adequate). These issues will be picked up again in chapter 6.

[156] In the event that we believe we have arrived at a solution in the form of a given theory (for example, Newton's theory of gravity), and in the event that another subsequent theory eventually replaces our first solution, there is a sense in which we may still regard the initial question as a correctly solved problem. Any given theory rests upon the respective constitutive framework, and so we may think of the theory as an answer to a question about a phenomenon, given the assumption of principles 1 to *n*, under the given constitutive framework (plus any additional assumptions, say, from other empirical results). Our understanding of the issue, question or phenomena is expanded with the replacement of an older theory with a new one and, subsequently, more precise assumptions are provided, and a new formulation generated, whereby our knowledge of the question is expanded, and other questions are revealed. In the case of Newton's theory of gravity, Newton may be thought of as solving a problem on the basis of (or relative to) his contemporary constitutive framework. The replacement of Newton's physics does not indicate any fault that Newton made, in proceeding from the basis of the geometry and calculus available to him.

[157] This being said, there is no way of knowing (short of arriving at a better question) that we *are* dealing with the wrong question, without the benefit of hindsight.

The need for a new question, or a new hypothesis in which concepts are categorised differently (or in which phenomena are given a differently constructed conceptual basis) does not indicate the presence of mystery in any way because the new question could be asked of either a problem or a mystery. The old concepts or questions should not be regarded as mysterious, and the need for reformulation supplies no stronger reason to infer that we have a mystery. Just as we cannot know in advance whether we face a problem or mystery, we cannot know in advance whether we have even hit upon the right question to begin with. As with the identification of problems, the identification of a legitimate question is also possible only by means of arrival at an answer.

In addition, we cannot know whether we have successfully landed upon the best way of posing the question for a given problem/mystery.[158] If we are trying to solve a problem/mystery, for which we have very little information, it follows (precisely because of our lack of knowledge) that there is no guarantee that we even know enough to pose the question adequately. If we don't have the correct question, lack of solution will characterise our attempts at progress, and therefore, we cannot identify whether we are dealing with a problem or a mystery. If we do have the correct question, this will only become known to us upon the solution of a problem, prior to which we will still only have a lack of solution (which in turn proves nothing about the problem/mystery *qua* its identification as a problem or mystery respectively). Where question-change looks to be potentially useful, therefore, the perceived likelihood of the need for a different question does not prove that the current question is definitely wrong (or even that it is necessarily poorly formulated), nor that any subsequent reformulation of the question will be the correct one.

[158] One might wish to identify a somewhat vague line between the case where a new formulation of question is given for the "same" problem/mystery, and the case where the provision of a new question indicates a distinct problem/mystery. One might ask, for instance, about the point at which the extent of change to the conceptual construction of a phenomenon, or to the question at hand, make it appropriate to say that we are, in fact, actually no longer dealing with the same problem/mystery. Such issues, however, do not bear upon whether or not the problem/mystery is mysterious. Where old conceptual formulations are dropped completely, then there is no problem/mystery at all, and therefore no possibility of a mystery; likewise, if a question is thought to be fruitless, then it is no longer posed as a problem/mystery and the issue of mysteriousness becomes mute. Note that, in such cases, a mystery may well persist (for instance, in those situations where we are struggling to even get our heads around the very question).

The inadequate posing of a question is a possibility for both problems and mysteries. In cases of apparent mystery, or at least persistent lack of success, the possibility of the reformulation of the question is a legitimate alternative. Again, the choice to work with a different question may be rational, but rational decisions about the course of inquiry must be distinguished from proof of the solubility of a problem/mystery in one way or another.

It is possible (in principle) to have a correctly formulated question, where we are nonetheless incapable of finding an answer. In other words, for any given mystery, the possibilities are (in principle) that humans will either be capable of understanding the respective question, or that the very issue will be utterly beyond humans' comprehension. The difference between the latter two types of mystery is understandable in principle, as it is logically possible, but is not something we can identify (let alone prove) within particular cases.

The need for an alternative question does not render the older question mysterious (for instance, in cases where a new constitutive framework is established). If we appear to have come to a dead end with a particular question or concept, it may well be that it is indeed not possible for us to arrive at a solution or answer, not because it is a mystery but because it actually requires that the question should be put differently, or the problem reframed. We have been mistaken in our *approach* towards a problem/mystery; but this does not imply that we are faced with either a problem or a mystery, one way or another.

A mistaken approach may be just as much because the domains in question need to be differentiated according to different terminology, meaning that a certain category is scientifically intractable but that the phenomena which are subsumed under that category could be reclassified in a way that allows progress to be made. For instance, a new constitutive framework may be needed; alternatively, minor revision to the established concepts may be sufficient. The possibility remains, of course, that some issues or phenomena are just cognitively beyond us.

5.5.4. Failure

There is nothing inherent in the continued lack of our success from which we can deduce or accurately predict infinitely continuous failure in the future. Suppose we take "dilemma-X" as the oldest unsolved dilemma in the history of human inquiry and consciousness. A perceived dead-end may lead us to make an inference to the best explanation that our question or concepts are poorly formed, or that dilemma-X is no longer worth inquiring into. Such an inference may be perfectly reasonable. But whilst we persist in the face of lack of solution, or if we decide to abort inquiry, no substantive closure is possible. In other words, failure is qualitatively different to success, because failure is not clearly marked by closure in an equivalent way.[159]

That the diagnosis of a problem is possible only by means of its solution effectively amounts to the assertion that we may only disprove the possibility that we are dealing with a mystery. No corresponding case is possible for proving that something *is* mysterious, or disproving the notion that it is a problem. No point of arrival, at an achievement or goal (for instance), is definitively available for cases of failure (whether for a mystery or a problem). We cannot logically deduce from failure (or rather, lack of success) the definitive criteria upon which to conclude that a concept or area of inquiry is mysterious. A lack of solution or answer is characteristic of both unsolved problems and mysteries, such that 'we cannot tell if we are dealing with a deep problem or a mystery' (Collins 2002, 127).

Even if we could somehow predict which areas will remain forever unsolved by humans, this would still not constitute sufficient grounds to declare it a mystery, because the existence of a mystery is not contingent upon the exogenous factors, and incidental circumstances, which help determine the set of problems that humans happen to get round to solving in actuality. So, to declare failure (or in other words to assert that a given domain or problem is mysterious, in the absence of reasonable suggestion as to how to proceed further) is to merely offer 'a *judgement* on the

[159] A comparison with Laudan's pessimistic induction (1981) could be fruitful here, as the case of as-yet-unsolved problems may be characterised as a sort of mirror-image of as-yet-unfalsified theories. Just as we cannot infer from the historical persistence of a theory that it tracks the *truth*, we cannot infer the intrinsic impossibility of solution from consistent failure. The commonality is that the persisting state of affairs regarding the status of an explanation (i.e., its acceptability or its absence, respectively) permits no inference to the certainty that such a status will never be subject to revision.

efforts made' (Collins 2002, 132), rather than a factual proposition about some conclusion.[160] It may be tempting to make an intuitive assumption that any given area in which humans have made no progress is just something that we were "never meant to know", but such an assumption just constitutes a judgement or inference, and does not offer comparable closure.

5.5.6. The regulative boundary between problems and mysteries

So far in the present section, I have defended the argument that we may not stipulate a strong problem-mystery demarcation. The possibility remains, however, to conceive of such a distinction in principle; in other words, the notion of the distinction is entirely permitted, even without a stipulation about where the demarcation should lie. The RB (Regulative Boundary), defended as a part of RKN, provides a useful characterisation of this looser notion of a problem-mystery distinction, by characterising how we may think of the boundary without positing a constitutive limit. Furthermore, the RB provides a principle which combines both the desired epistemic modesty and investigative optimism.

Recall that the RB amounts to a regulative guide to our scientific inquiry, by positing an ideal boundary notion which provides both the limit, as well as the unity, to the totality of science. Such a regulative ideal reminds us, in its heuristic role, of both the inherent limits to our capabilities, as well as our contingent ignorance at a particular stage of inquiry. By positing the regulative notion of the unity of, or boundary for, completed inquiry, the incompletion of our present understanding is set into relief, relative to that total unity; a contrast, in other words, is set up between our present knowledge and the potential knowledge available to us. Such a contrast, in turn, may be used to inspire investigative motivation and optimism, as the ideal

[160] "Failure", in the case of scientific or epistemological problems, often constitutes an assessment that some pursuit or project is no longer worth the effort, given the predicted likelihood of completion or some other favourable outcome. In other words, it constitutes a judgement about the probability of future success or failure, or an inductive inference to the best explanation. Failure in inquiry does not have the same finality as, say, producing conclusive results for a theory, finishing a jigsaw puzzle or cross-word, or solving an equation, all of which have a clear mark of completion. Failure to solve a problem of inquiry, on the other hand, is characterised by *in*completion without any relation to a given fixed and identifiable aim, and so necessarily cannot be measured against an equivalent inevitable arrival or finishing post in the same way. We might say (for the sake of underlining this point) that to solve a problem is something we do, but to declare failure is something about which we make a decision.

limit opens up the notion of how much further our potential may take us. At the same time, the unity of the total completed science not only reminds us of our present ignorance, in contrast with our ideal capacity for scientific understanding, but emphasises the notion that there is ultimately a limit to scientific understanding, even if we may only conceive of this in a regulative way.

We are reminded, in other words, that there are still problems to be solved, whilst certain potential problem/mysteries will necessarily be beyond our grasp; the RB reminds us, therefore, of the distinction between problems and mysteries without needing (and indeed, not permitting) a constitutive boundary.[161]

5.5.7. The notion of "mysterious" aspects of cognition

Although McGinn's proposal about the mysteriousness of consciousness is motivated by naturalism and epistemic modesty about the cognitive capacity of humans, his ideas provide no exceptions to the argument given above. Whilst he concedes that 'historical failure is suggestive, but scarcely conclusive', McGinn continues by explaining nonetheless that 'our deep bafflement about the problem … should encourage us to explore the idea that there is something terminal about our perplexity' (McGinn 1991, 7). Such an "encouragement" is comparable to the case where we might make an inference to the rationality of aborting a certain investigation (c.f.: §5.3.2, above in this chapter) but as I have argued, such an inference is a judgement call, and not the basis upon which to declare something mysterious.

If one holds up the notion of the RB (as an instantiation of the extent to which we may conceive of the a problem-mystery distinction) for comparison against the idea of "suggestive" failure as the mark of a mystery, the RB sets into relief the difference between acknowledging *that* we are limited on the one hand, and

[161] The RB pertains to the boundary conditions to a unified completed science. This is not to suggest, however, that all problems must be solved via scientific inquiry. Nonetheless, for the purposes of this section, where problems may be conceived as covering all human questions, one sub-set of which is the set of scientific questions, then the RB may still be taken analogously as a characterisation of the problem-mystery distinction. In other words, something closer to the noumenal-phenomenal-boundary may be used as the relevant regulative boundary notion (c.f.: chapter 4, §4.5).

drawing sharp parameters to those limits, on the other.[162] The illegitimate demarcation of sharp boundaries is precisely what McGinn's arguments amount to, which point is illuminated in a striking manner by the RB. All that McGinn is permitted to do is to suggest that it might be worth our while focussing investigative attention elsewhere, but his argument does more than posit a suggestion.[163] The RB, as an instantiation of the type of boundary permitted for the problem-mystery distinction, disallows the outright assertion that a problem/mystery is a mystery. What is left, however, is McGinn's epistemic caution about our limits for inquiry.

McGinn's proposal may be rejected upon purely methodological grounds according to the criteria for naturalism, quite independently from the issues surrounding identification of mysteries.[164] McGinn's argument consists in identifying a physicalist model of the "material", in mereological terms, against which he contrasts the mental. As I have argued, no such construal of "body" or "matter" is justified by scientific understanding. McGinn identifies the type of phenomena that are tractable to lawful explanation (and about which we may reason in a lawful way) as anything which may be described as:

> atomic elements combining according to certain laws and mapping intelligibly onto the facts to be explained—parts and wholes, basically. But this is just what we are prevented from doing in the case of consciousness and the brain: conscious states are not CALM-construable products of brain components.
>
> (McGinn 1993, 37).[165]

The expectation that either bodily or mental phenomena should be construed in terms of "parts and wholes", and that the mechanistic notion of body should prevail (against which we are to contrast the mind), are grounded in Cartesian conceptions of body and mind, which have subsequently been disproved (c.f.: chapter 2,

[162] Ironically, our inability to draw a sharp demarcation between problems and mysteries is precisely the sort of cognitive limitation to which McGinn refers in order to try and establish that very demarcation; he claims, for instance, that our attempt to solve a significant number of philosophical problems amounts to an activity which is beyond our mental capacities as humans (McGinn 1993, 2).

[163] A similar move is made regarding the other philosophical problems he deems mysterious, such as the mind-body problem (McGinn 1991, 26-9). C.f.: (McGinn 2004, chapters 1-3).

[164] For further critical discussion of McGinn's ideas, see: (Bilgrami and Rovane 2005).

[165] C.f.: (McGinn 2004, chapter 4).

§2.3.1).[166] The very distinction he seeks to draw, then, between the properties of consciousness and the physical phenomena for which we can generate lawful theories, is a distinction based on outdated concepts and mistaken notions of science. As demonstrated in chapter 2, such approaches to the mind are explicitly non-naturalistic. Likewise, the consideration of whether or not mental phenomena are lawlike has also been demonstrated to be a mute problem (c.f.: chapter 2, §2.3).

5.5.8. Consequences from McGinn's ideas

The simultaneous demonstration of both our limits to and potential for inquiry, throws into sharp relief the anti-naturalistic nature of the very idea of writing off a given domain as necessarily mysterious. Reconsidering McGinn's diagnosis of a mystery, according to other aspects of RKN, highlights a useful alternative approach to consciousness. Remembering the constitutive framework which supplies the relativized principles of a given stage of science, we may distinguish between two ways in which humans are capable of problem-solving. There are those problems which humans are potentially capable of solving *per se*, and those problems which humans are potentially capable of solving from within the context of the given constitutive framework, currently available (where the latter problem-type is a sub-set of the former). Our potential for problem-solving is dependent upon our cognitive capacities in their ultimate limit, but such potential also depends upon the distinctly collective use of our various human capacities, in the wider institution of science; the solutions we are (potentially) capable of generating in the present depend upon the current set of conditions available to us (our current constitutive framework, our technology, and so on). As already demonstrated in chapter 3, conditions such as the current constitutive framework are not mind-dependent,[167] and so our present potential should not be taken as any indication of our full cognitive potential, in principle. The notion of absolute or total human capability for scientific

[166] We can compare his definition of naturalism towards the mind, as 'the thesis that every property of mind can be explained in broadly physical terms' (McGinn 1991, 23), to explicitly physicalist approaches to naturalism (c.f.: chapter 2, §2.2.1 and §2.3.1), and McGinn's picture of the realm of the physical concerning "parts and wholes" to the respective physicalist construals (c.f.: chapter 2, §2.3.1 and §2.3.6).

[167] In other words, the conditions for the possibility of scientific inquiry are not entirely, or even predominantly, grounded in the structure of our cognition; such conditions extend beyond the individual mind and across different groups and generations of thinkers. C.f.: chapter 2, §2.5.2; chapter 3, §3.3.2.

achievement, in principle, must be distinguished from what humans are capable of understanding or solving (again, in principle) at a given stage within scientific inquiry, where the latter is dependent upon the particular constitutive framework and the intellectual work done to date. Despite the relative nature of the constitutive framework, both types of potential are expressed in modal claims about what is possible in principle. Human scientific capabilities, at a given point in time, are relative to the prevalent theoretical assumptions; such constitutive frameworks simultaneously limit but make possible the extent to which scientific progress may be made. (Ptolemaic astronomers, for instance, couldn't have been expected to come up with Einstein's relativity theory, as they simply didn't have access to the required conceptual and mathematical groundwork).

Recognition of the two types of cognitive potential draws attention to important aspects of the limits and potential for scientific inquiry. First of all, we are reminded that science is not a mind-dependent institution. Secondly, it highlights the revisable nature of our theoretical concepts. Where a given concept does not appear fruitful, instead of inferring that the problem/mystery is mysterious, we may explore the idea that a different way of conceptually framing or constructing phenomena, or that the introduction of a new taxonomy, may be more fruitful.

Our talk of "consciousness" may, therefore, turn out not to be the best way in which to divide natural phenomena (it may, for instance, turn out to be no more than a folk notion).[168] For instance, Pylyshyn points out that 'we have no right to the a priori assumption that the set of conscious contents is a natural domain'; instead, it is highly likely that we will need to 'draw the boundary around phenomena in such a way as to cut across the conscious-unconscious distinction' (Pylyshyn 1984, 264-5).

We must distinguish between (and not conflate) the realisation that a certain taxonomy or set of theoretical concepts is unsuited to a particular form of investigation, and the assertion that the phenomena themselves are inherently unsuitable for any form of naturalistic inquiry whatsoever. With a change in theoretical concepts, we may very well transform our notions of various phenomena;

[168] I mean not to imply that terms like "consciousness" should be taken out of every day discourse, as they function perfectly well for our purposes in such contexts. C.f.: (Collins 2007).

but with such alternatives, more progress may be made. Changes in theoretical constructions do not constitute evidence that a particular respective natural domain is somehow intractable. Changes, for instance, as to what is meant by an "atom" or "particle" have never caused a physicist to throw up their hands, declare atomic physics naturalistic intractable and give up. The different and updated conceptual basis, from which physics proceeds, does not amount to any aspect of physics being naturalistically intractable. It means that there is some category under which it no longer makes sense to classify (or even construct) phenomena, but it cannot be taken as evidence that the domain in general is out of bounds to inquiry. In another example, with the shift from absolute space and time, to spacetime, no one supposes that absolute space and absolute time have been proved mysterious. In contrast, we have obtained what we hope will be a more fruitful understanding of phenomena, which does not make previous conceptions mysterious but merely indicates that they may be wrong or at least inaccurate (qualifications about epistemic certainty aside).

Where the RB guides us away from premature labelling of certain domains as mysterious, the following point is set into relief: where a given domain for inquiry turns out to be unfruitful, it does not follow that we have found a naturalistically intractable subsection of the universe. Just as we cannot assert outright that a problem/mystery is a mystery, we are also in no position to claim that we have correctly identified the best way of dividing up the phenomena. We cannot rule out the possibility that there is some other more fruitful way of carving out domains for inquiry. In the case of the mind, as we have made comparatively little progress, the chances of an alternative way of conceptualising phenomena are reasonable high.

Another brief point is worth making, in connection to McGinn's proposal of a mystery. McGinn worries that there is some sense in which we are inherently unable to reflect rigorously upon the human mind; the concern is that the inherent limits of cognition necessarily make certain aspects of the mind inaccessible to us. Such a worry perhaps stems from the notion of attempting to achieve systematic closure from within that same given system (so that the mind, in trying to think its own limits, would simultaneously try to transcend, and attain closure to, such a limit). But RKN draws out the fact that any cognitive capacities used within inquiry do not constitute the sum total of the set of necessary and sufficient conditions for scientific investigation or theorising. The full set of empirical as well as intellectual conditions, which provide the possibility for scientific inquiry, are not grounded in uniform endowments of the mind, and are spread across a wide range of individuals and groups. The conditions for the continuation of inquiry, therefore, are not mind-dependent. So inquiry in cognitive psychology does not amount to embarking on investigation into a given object of inquiry, using the very same object as a tool for inquiry (as would effectively be the case if the conditions for the possibility of all inquiry *were* mind-dependent).

Self-reference is a concern for cognitive psychology, not as an issue taking the form of a Kantian antinomy, but as a question about how best to account for apparently global processes. Very simply put, we are able to assess thoughts across a wide range of considerations (for instance, we are able to reflect on our beliefs from very different aspects of our lives, bringing those beliefs to bear on novel situations, or comparing them with beliefs from another area of life). But we are not yet sure how human cognition is capable of sorting and assessing types of cognition. For any massively modular system, an explanation is required for how different domains can interface (which would require some degree of compromise with the criterion of encapsulation), so as to allow for plasticity of thought and global processing.[169] In the case of global reasoning, the less we are able to specify the development of the competence, the less we are able to identify species-wide uniformity (for instance, of initial or developed states), and the less we are able to say about what sort of input the faculty may receive in order to generate specific sorts of output (and so the harder it becomes to account for a faculty competence).

At the same time, a non-modular mind throws up other issues for how we should proceed with cognitive psychology (Fodor 1983, 127-9). One particular area of thought which looks as though it requires global reasoning or processing is, according to Fodor, the very set of cognitive skills involved in being able to comprehend and reason about scientific inquiry.[170] Such difficulties, however, unlike

[169] See for instance: (Carruthers 2005); (Fodor 1983; 2001); (Sperber 2005).
[170] For the specific difficulties regarding concept-formation, abductive reasoning or other potential cognitive skills that might feature within scientific inquiry, see: (Carey and Spelke 1994); (Fodor 1983, chapters 4-5; 2001, chapters 3-4).

McGinn’s difficulty with consciousness, are concerns for naturalistic inquiry; very difficult questions are opened up, but we have no reason not to pursue them.

5.6. Epistemic modesty and investigative optimism

From the arguments given, and the detail of the RB in the assessment of McGinn’s ideas, the idea of demarcation a strong problem-mystery distinction cannot be permitted. However, Chomsky offers his SFF from a genuinely naturalistic position (c.f.: chapter 2). The SFF, therefore, bears some further examination.

When compared to the LF, the strong notion of the SFF fails to exhibit the minimal characteristics expected of a faculty. First of all, a faculty will develop in a relatively uniform fashion, so that various developmental stages are reasonably predictable and so that the full capacity matures automatically (for instance, as we would expect from the hormonal system).[171] Secondly, such development should be uniform across the species so that ‘the competence should reach normal maturity in the face of a *poverty of stimulus*’ (Collins 2002, 136). Although different languages are learned according to the environment, the rate of development is standard rather than specific to each individual or language. In the case of language, the acquired competence is used automatically and with no conscious understanding of the deeper structural rules employed.

Neither characteristic holds for scientific practise. No one becomes a competent scientist merely by virtue of the full development of their cognitive capacities. The development of an understanding of physics takes deliberate hard work in order to grasp the ideas in physics. Specific training is needed, and whilst we might develop some set of basic capacities enabling us to learn on a more generalised level, no competence in physics is found across the species (let alone in such a manner whereby standard developmental stages may be identified). For instance, consider the rate at which children acquire language;[172] it is uniform

[171] C.f.: (Chomsky 1975, 11; 1993, 29).
[172] For instance, children are able to ‘effortlessly make use of an intricate structure of specific rules and guiding principles’ (Chomsky 1975, 4).

enough to predict the age by which a child should be a competent language user (Chomsky 1980/2005, 139; 1988b, 408-10). Such development is determined to an extent which allows us a notion of what it means for a child to be a late learner of language, in cases of anomaly or pathology. We have no equivalent notion of what it should mean for an individual to be a late developer of their understanding in physics or scientific reasoning, as far as we know (Chomsky 1975, 155-7; 1988a, 157).

As it is ‘doubtful that “general learning mechanisms” … play a major part in the growth of our systems of knowledge’ (Chomsky 1988a, 48), the SFF can be taken as something more specific than a general purpose system. Even so, whilst ‘we may assume it to be fixed, in the manner of the language faculty’ (ibid., 156), important differences persist:

> In the case of the language faculty that is a central element of the human mind. It operates quickly, in a deterministic fashion, unconsciously and beyond the limits of awareness and in a manner that is common to the species, yielding a rich and complex system of knowledge, a particular language. For problem solving and theory construction there is nothing so specific.
>
> (ibid., 157).

In short, whilst people of a similar educational background may fairly easily equally understand and assess a hypothesis, both the problems of science and the individual capabilities of the people who consider them, are way too varied to count as having the properties of the language faculty, as described above.

Ideally, in order to establish a notion which tells us something about the problem-mystery distinction, we need something which allows the identification of a skill or skills which are specific to scientific thought or theory formation, or something which indicates the possibility of a constraint upon thought within the area of specifically scientific reasoning. A full assessment of what a faculty should amount to is not possible, but Collins (2002) provides independent reasons (according to the criteria for faculties) as to why the notion of the SFF does not work; indeed, he concludes that ‘it is unclear what the SFF thesis amounts to’ (ibid., 149).

Note, however, that Chomsky himself is sensitive to the differences between the development of the LF and of any cognitive skills inherent in scientific reasoning (Chomsky 1975, 155-6). Although our acquisition of knowledge of physics will be based on ‘specific properties of the mind, it does not reflect these properties in the same way as language [does] … Hence the vast qualitative difference in relative accessibility’ (ibid., 157). Furthermore, any scientific understanding will not develop as our LF does, where the maturation of our linguistic capabilities happens in line with our physical growth, at a predictable uniform rate (Chomsky 1980/2005, 139-140). Chomsky notes that the LF is a digital, infinite system, and we appear to have few other faculties alike in this respect. He explains that ‘[l]anguage is, at its core, a system that is both digital and infinite. To my knowledge, there is no other system with these properties, apart from the number system’ (Chomsky 1991b, 50). But in understanding the mind to be made up of ‘distinct subsystems’ rather than general-purpose mechanisms, we should still expect ‘qualitatively similar [systems] in other domains’ (ibid., 51).

Chomsky is also very sensitive to the fact that the potential of the SFF depends upon whatever background assumptions are available as inputs, from the respective stage of scientific inquiry; whatever the cognitive skills used, our reasoning capacities still depend upon the relative stage of inquiry and the scientific principles developed at that stage (Chomsky 1988a, 156). Such sensitivity suggests that whilst Chomsky is optimistic that some progress will be made in establishing the cognitive skills involved in scientific reasoning, whatever we discover will exist in a highly complex relation with the other factors entering into scientific inquiry, as well as other features of cognition. Whilst the strong SFF fails as a means by which to demarcate the distinction between problems and mysteries, the extent to which it nonetheless proves useful is precisely to highlight the very ideas which are born out of the RB.[173]

A more liberal notion of the SFF might be construed, whereby “SFF” just refers to whatever cognitive basis we have for the collective principles and reasoning

[173] The modesty of Chomsky’s proposal is emphasised by assertions that the most basic capacities should be understood first, before we move on to trying to grasp the underlying structures of the more sophisticated or peripheral cognitive skills possessed by all (or even just some) humans (Chomsky 1975, 27-8).

processes that are utilised in scientific theorising and inquiry (Collins 2002, 136). This set of cognitive skills, however, does not imply the sort of specificity that we would expect from a faculty (however broadly we may understand the notion of a "faculty"). Such labelling of a set of skills, processes or reasoning principles is potentially useful as an initial way of categorising a certain aspect of cognition to be studied further. We needn't restrict the notion to just one faculty; likewise, we needn't think of any general purpose system.

Suppose we consider the possibility that the SFF consists of a collaboration between, or the net result of, several domain-specific competences or faculties (ibid., 140). This could be conceived as something like the domain-specific cognitive system suggested by Carey and Spelke (1994), which accounts for domain-specific processing as well as the sort of cross-domain reflection, or non-domain-specific reasoning, which seems to be necessary for the capacity to understand conceptual change which occurs within (for instance) scientific progress (ibid., 179). What they suggest is a hypothesis of analogical 'mappings across domains' (ibid., 179); such use of analogy, however, does not help out the notion of a SFF because 'anything is analogous to anything else' (Collins 2002, 141). At best, the hypothesis suggests something about what cognitive capacities (or combinations thereof) might be used by someone engaged in scientific theorising. Analogical reasoning may be one of the cognitive skills we draw upon during formation or analysis of scientific hypotheses or theories, but our ability to use analogy is a type of reasoning potentially applicable to any domain of thought or area of life. Analogy, therefore, is not specific to science; furthermore, because analogy is precisely that means by which we may compare concepts to an indefinite degree, little restriction is placed on the specific type of ideas which it might help to generate. (For instance, there is no guarantee that an analogy will be correct). Such a suggestion does not imply a strong enough need for a faculty, or even for a set of faculties, by which a clearer distinction between problems and mysteries could be drawn.

Essentially, we arrive back at the weak construal of the SFF in which we posit the set of cognitive capacities (in some arrangement of cognitive architecture, specified functions, and so on) which an individual utilises within scientific reasoning. Such a speculation gives us no reason to suppose that the respective set of capacities, faculties or processes should necessarily be specific to scientific thought *per se*, and so what this amounts to is that there is likely to be some structure to the various cognitive capacities used when undertaking scientific reasoning.

The RB emphasises the notion, however, that a future understanding of such aspects of our cognition, at least liberally construed, is something we can hope for, and aim towards, in some form or another.[174] A liberally construed SFF just says that something about our cognitive architecture places limits on those cognitive capacities which are utilised for inquiry. Although permissible, this claim is not strong enough to allow a determinate demarcation, via our faculty structure, between the domain of problems and the domain of mysteries. All the liberal SFF tells us is that there is *some* cut-off point to our the human potential capacity for naturalistic problem-solving. This is the case whether or not a specific faculty is in place; as such, "SFF" becomes a pragmatic term for whatever our cognitive capacities turn out to be, with respect to scientific theorising (where no faculty thesis is needed). Combined with the RB, however, the SFF may remind us of our potential for future inquiry, in terms of both the degree of our present ignorance as well as the hope for possible future inquiry. This is because the RB instantiates both the epistemic modesty and investigative optimism inherent in the very idea of the liberal construal of the SFF.

Positing a hard and fast boundary is not only premature, but the very assertion contains within itself an attempt to reach beyond the boundary it purports to delineate. Crucially it is important to note the difference between 'hypothesis[ing] coherently cases of mystery … [and achieving] a demarcation of them' (Collins 2002, 127). Chomsky concedes that there is no need to assume the omniscience of humans as we 'are biological organisms, not angels' (Chomsky 2000, 74). But it

[174] Recalling the regulative notion of unity which makes possible the modality of lawful generalisations, our capacity to think a totality (such as this) may turn out to be an aspect of our cognition which can be investigated further within the course of cognitive science (albeit, in the far off future). I should emphasise, however, that I do not propose our capacity to think about unity and totality as the basis for some distinct faculty. Just as in the case of our capacity for analogical reasoning, our capability to think of totality and unity *might* be something which is further understood after advances are made in cognitive science, but we are a long way off grasping the architectural basis of such types of thought or reasoning. Equally, the very possibility for eventually understanding modal thought via cognitive science should by no means be read as an entailment of the RB: it is an issue left to inquiry itself.

does not follow in the least that we can specify or quantify the boundedness of human cognition; neither does it follow that, if we cannot endogenously demarcate certain limits according to cognitive architecture, then we are forced to conclude that we are epistemically unlimited. If Chomsky's intentions are just to mark up an acknowledgement of the limits of human capability, then this is possible without a specific mental faculty.

What we find, however, is that, although it is by no means meant to be a part of our cognitive architecture, the RB precisely embodies the underlying optimism for advancement as well as epistemic modesty, both of which are inherent in the methodological attitude underlying Chomsky's proposal of a SFF. We may view the RB as guiding us away from the notion of a sharp problem/mystery distinction; but we may also view it as a regulative tool for drawing out the subtlety and proper investigative attitude inherent within Chomsky's suggestion of a SFF. The fruitful aspect of the notion of the SFF, therefore, drawn out by the application of the RB, offers a humbling but hopeful picture of where we are at, and of where we might aim towards, in our understanding of those cognitive skills that enter into scientific inquiry.

5.7. Conclusion

The RB allows a regulative notion of our limits without any constitutive demarcation of that limit. The RB is a principle which guides our investigative optimism by bringing to the fore the regulative notion of how much potential progress there is yet to be made; simultaneously, it is a bounding principle which reminds us of both our present ignorance as well as our ultimate limitations, with reference to the ideal notion of a completed unified science. The RB therefore maps onto our notion that there are mysteries, but forbids any claims to knowledge of what these might be.

By its regulation of inquiry, and by its very definition, the RB encompasses the ideas of both epistemic modesty and investigative optimism. Even so, the RB does not provide a naturalistic determination of problems and mysteries, but the opportunity remains for us to make advancements in understanding those are of cognition which contribute to our collective capacity to think scientifically and make scientific progress. The RB is not intended to explain the cognitive features of our scientific capability and so in this way does not serve to replace the SFF; the RB merely demonstrates that no SFF is needed in order to understand some problem-mystery distinction, and to accommodate the fact that whilst we cannot stipulate where our own investigative limits lie, we may understand, all the same, that we are necessarily limited.

Chapter Six:
Investigative Modesty and Ontic Structural Realism

6.1. Introduction

In the previous chapter, I demonstrated that the RB (the Regulative Boundary) is usefully applied to issues about the limits and potential of cognition and of cognitive inquiry. As seen in chapter 5, we are a long way off a scientific understanding of the particular cognitive capacities which go into scientific thought; this chapter turns to the ontological status of the theories themselves, and the constitutive principles and constructs upon which they are developed.

I shall argue in the present chapter that RKN (Revised Kantian Naturalism) provides a unique means by which to support the favouring of ontic structural realism over constructive empiricism, within the current debates surrounding structural realism. RKN entails neither constructive empiricism nor ontic structural realism definitively, and the argument of the present chapter is not intended as a wholesale rejection of constructive empiricism (nor a blanket endorsement of every detail of ontic structural realism, as absolutely correct). Constructive empiricism retains many important and useful characteristics, and ontic structural realism will nonetheless have further problems to iron out. I shall demonstrate that RKN provides a useful and novel way of drawing out the fact ontic structural realism both accounts for those beneficial features of constructive empiricism, whilst also providing additional and significant insight. RKN offers such support in a unique way which explicitly ties together the principle of a unified science, with the investigative optimism and epistemic modesty characteristic of both constructive empiricism and ontic structural realism.

6.2. Scientific realism, anti-realism and structuralism

6.2.1. Scientific realism

In order to demonstrate the advantages of ontic structural realism it will be necessary to consider the benefits of the constructive empiricist account of scientific epistemology. Before doing so, however, I shall ground both positions within the context of broader debates surrounding scientific realism, anti-realism and structuralism. Scientific realism may be characterised as the attempt to explain the success of scientific inquiry, on the basis of the idea that our scientific progress should not be considered miraculous. Such a consideration is often referred to as the "no-miracles" argument.[175] The argument (often construed as a form of Peircian abduction) works on the basis of inference to the best explanation, and may be summarised as follows: if we do not want to attribute scientific success to some coincidence or miracle, then in the face of our undeniable scientific progress, we must conclude that scientific theories capture what is true about the world. In other words, '[*s*]*cience aims to give us, in its theories, a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true* [author's italics]' (van Fraassen 1980, 8), giving us licence to believe in the true reality of unobservable phenomena posited by theories. Put otherwise, if theories do not track the truth of reality, then it seems bizarre (or miraculous) that they should be so successful. At first glance, then, scientific realism appears to offer a position which takes seriously the advances and practices of science.

Amongst various problems identified within the no-miracles argument,[176] the occurrence of significant theory change causes a difficulty, because previously established theories have their truth undermined, and as a corollary, the existence of the entities posited by that theory is also challenged. Put otherwise, scientific realism entails the notion that philosophers of a previous period were obliged to commit to

[175] The argument has been attributed to various philosophers. Lauden (1981, 20) and van Fraassen (1980, 8) attribute the argument to Putnam, amongst others; see, for instance: (Putnam 1975, 73). Worrall (1989, 101) identifies the argument in Poincaré's work (1902/82), for example, although Van Fraassen also characterises it as a more recent position, formulated in objection to the model of science developed by logical positivism (van Fraassen 1980, 1-6).
[176] For detailed accounts of both the argument, and its potential difficulties, see: (Ladyman and Ross 2007, 68-83); (Lauden 1981); (van Fraassen 1980, chapter 2); (Worrall 1989).

the truth of a set of scientific theories which were subsequently rejected (i.e., to commit to the supposed truth of a falsehood). Since we have no guarantee that present theories and conceptual constructs will not be revised at a later stage, there is the chance that the new scientific theory (to which we are supposed to commit, *qua* a true description of the world) will also be falsified. Such a contradiction is precisely one of the motivating criticisms of anti-realist positions such as Laudan's (1981).

6.2.2. Epistemic structural realism

Structural realism offers a means of preserving the idea that there is indeed some rationality to believing our best current theories, whilst bypassing the difficulty of ontological discontinuity over theory change, by proposing that scientific theories actually track the structure of the real world (Worrall 1989).[177] The success of scientific explanation, therefore, is not deemed miraculous; furthermore, as scientific theories identify real structures in the world, and as it is possible to argue for the preservation and continuity of structure in cases of theory change, the hurdle is subsequently addressed.

Different varieties of structuralism, namely, epistemic structural realism and ontic structural realism, spell out our understanding of such structure in alternate ways. Epistemic structural realism is the thesis that all we can know is the structure identified by (or, underlying) scientific theories. Ontic structural realism endorses the claim that scientific theory latches on to real structure, where all that is real is structure. In both cases, structure is thought to persist to some extent over theory change, so that ontological discontinuity is no longer a problem.[178]

According to epistemic structural realism, theoretical entities may exist, but all we can know about them is their structure. Any knowledge of unobservable objects is just by the structural properties and relationships, represented in logical or mathematical form (Ladyman 1998, 412). One central suggestion for just how a

[177] Worrall (1989) makes this point especially clear, although he should by no means be thought of as the first proponent of structural realism. Some form of structural realism has been attributed to those such as Russell (1927/54) and Maxwell (1970).

[178] For comparisons of both varieties of structural realism, see: (Ainsworth 2009); (French and Ladyman 2003a); (Ladyman 1998); (Psillos 2001). C.f.: (Chakravartty 2003; 2004); (Ladyman and Ross 2007, chapter 2).

theory represents structure, according epistemic structural realism, is by means of the Ramsey Sentence,[179] whereby the terms and relations of a theory are represented in second order logic. The main problem with the Ramsey Sentence approach, however, is that any given structure may be recreated by any set of objects and their relations. The structural properties identified within a theory, therefore, are not unique to the theory which the structure is said to represent. Ladyman sums up the difficulty very well, as follows:

> The basic problem is that structure is not sufficient to uniquely pick out any relations in the world ... The *formal* structure of a relation can easily be obtained with any collection of objects provided there are enough of them, so having the formal structure cannot single out a unique referent for this relation
>
> (Ladyman 1998, 412).[180]

The challenge remains, then, for any advocate of structuralism, to supply an account of structure which does not collapse in the way described above, and which fulfils the objectives of the structuralist aim.

Both ontic structural realism and constructive empiricism seek to provide a more successful account of scientific rationality than epistemic structural realism, whilst also aiming to avoid the problems faced by scientific realism. In order to understand the benefits of ontic structural realism, over constructive empiricism, the value of the latter must be considered. In fact, one could argue that RKN offers support for constructive realism; in the next section, therefore, I shall therefore consider the arguments for, and benefits of, constructivism empiricism, as well as the potential support offered by RKN.

---

[179] For arguments in favour of epistemic structural realism, see: (Melia and Saatsi 2006); (Maxwell 1962; 1970).

[180] C.f.: (Ladyman 2007, 124-8). Such a point is raised against attempts to rescue epistemic structural realism (Demopoulos and Friedman 1985), and it reiterates the objection raised by Newman (1928), in response to Russell (1927/54), known as the “Newman objection”. Van Fraassen asserts that the ‘syntactically defined relationships’ of both the positivist attempts, and of the approaches utilising the Ramsey sentence, offer inadequate accounts of scientific theories (van Fraassen 1980, 56); upon the Ramsey sentence approach, ‘the distinction between truth and empirical adequacy reduces to triviality or absurdity’ (ibid., 55). C.f.: (ibid., chapters 1-2).

6.3. Constructive empiricism

6.3.1. Empirical adequacy

Constructive empiricism offers an account of the rationality of scientific theories, according to which theories are acceptable by virtue of their empirical adequacy. Empiricism endorses a respect for scientific evidence in our philosophy of science, via the premium placed on evidence; as such, 'empiricism requires theories only to give a true account of *what is observable* [author's italics]' (van Fraassen 1980, 3). In other words, 'the belief involved in accepting a scientific theory is only that it "saves the phenomena", that is, correctly describes what is observable' (ibid., 4). The criterion of empirical adequacy, for the rational basis of theory-acceptance, is asserted in keeping with van Fraassen's empiricist approach to the epistemology of science. We must honour what the empirical evidence shows us, according to van Fraassen, but not attempt to make claims for anything beyond what is given by that evidence. The central thesis of constructive empiricism is therefore that '[*s*]*cience aims to give us theories which are empirically adequate and acceptance of a theory involves as belief only that it is empirically adequate* [author's italics]' (ibid., 12).

Van Fraassen points out, in objection to the no miracles argument, that the terms of a given scientific theory are, in fact, theory laden; as such, the truth or falsity of such propositions (and thereby, the truth or falsity of the theory) can only ever be theory-relative. There is, in other words, no guarantee of truth just from the successful application of a theory; at the same time, the idea that theories do not aim at truth is no reason to suppose that they are miraculous. According to the constructive empiricist, any explanation of scientific success is not, however, the concern of the philosopher.

Van Fraassen's commitment to empiricism manifests itself in the resistance towards accepting any metaphysical claims, precisely because they extend further than the information demonstrated by the evidence. In addition to his objection to the notion that science aims at capturing truth, van Fraassen raises a number of concerns about inference to the best explanation, used within the no-miracles argument of scientific realism. For a start, if we are to commit to the truth of a given statement *x*, and if the inference to the best explanation would lead us to *y*, then we are still perfectly licensed to abstain from believing *y*. In other words, in the case of an inference to the best explanation, nothing about *x* forces us to believe *y*. Van Fraassen explains this point with the illustration that '*modus ponens* allows you to infer *B* from *A* and (if *A* then *B*), but does not forbid you to infer (*B or A*) instead' (van Fraassen 1980, 20). We may refrain from forming any belief whatsoever about such a best explanation.[181]

Even if we accept the notion of inference to the best explanation, in order for such an inference to be made, there must be an implicit willingness to commit to one or another of a range of possible propositions. Presented with the range of options from which to choose, an inference of this sort instructs our choice; but if such a choice is going to take us from the scientific results, to the truth of scientific theories (*qua* explanations of the phenomena), then some premium needs to be placed upon the very importance of seeking such an explanation in the first place (scientific results themselves do not oblige us by necessity to find some explanation). Some reason is needed, in other words, to account for why an explanation should be given in the first place, in addition to what the empirical evidence tells us.[182] As van Fraassen explains:

> The realist asks us to choose between different hypotheses that explain the regularities in certain ways; but his opponent always wishes to choose among hypotheses of the form 'theory *Ti* is empirically adequate'. So the realist will need his special extra premise that every universal regularity in nature needs an explanation
>
> (van Fraassen 1980, 21).

[181] For more detail on van Fraassen's response to the no-miracles argument, see: (Ladyman and Ross 2007, 72-5). For an argument against van Fraassen's particular objections towards inference to the best explanation and abductive reasoning, see: (Psillos 1996).

[182] Underdetermination of the truth of one theory over another might be relevant to the reluctance of the constructive empiricist to accept a realist explanation of the success of science; where data does not determine the higher value of one theory over another, the scientific realist's inference to the truth of unobservable entities (as posited by the theory) might lose its legitimacy, precisely because the reality of an alternative set of unobservable entities looks just as credible, according to the data (Ladyman and Ross 2007, 80). Even so, underdetermination arguments 'do not seem unequivocally to support either realism or antirealism' (ibid., 82), and furthermore, van Fraassen himself does not draw upon such considerations in his defence of constructive empiricism (ibid., 81-2); I will, therefore, not dwell on this issue.

According to an empiricist understanding of scientific rationality, an explanation for why the evidence should be this way takes us beyond the set of claims we can make according to the empirical data. Thought of another way, the acceptance of a scientific theory may be based upon a number of different criteria, and another criterion is the consideration of how well a theory accounts for the relevant data. Theory-acceptance is useful for the scientist, for the sake of exploring different phenomena under a given framework, or as a practical aspect of pursuing a certain line of research. Acceptance of a theory, therefore, is just as much a pragmatic activity, as it is the commitment to a belief, for van Fraassen (1980, 88). Deciding to accept a theory may therefore be understood as an act of endorsing its empirical adequacy, rather than an act of commitment to its truth (ibid., 71).

6.3.2. The observable and unobservable

Although van Fraassen concedes that our scientific concepts are highly theory laden, he still endorses the credibility of an objective distinction between the observable and unobservable.[183] "Observability" and "unobservability" are relative terms, as are any descriptive predicates taking the suffix "–able"; in other words, they are '*vague predicate*[*s*] [author's italics]' (van Fraassen 1980, 16). Whilst relative, the terms "observable" and "unobservable" refer objectively to their respective categories, because we may understand observability with regard to that which is observable for humans. We do not, for instance, think of the Empire State Building as portable just because it is logically conceivable that (say) aliens may be able to transport it.[184] The expanded range of possible conditions, created by the various inventions or tools for data-gathering, might allow a new phenomena to be deemed observable; but these conditions should be specific to what is specifically humanly possible (we cannot account for conditions under which we have a different visual system, for instance).[185]

[183] Van Fraassen presents this claim in contrast to Maxwell's arguments for the notion that no observable/unobservable distinction can be made whatsoever (van Fraassen 1980, 11-9). C.f.: (Maxwell 1962).
[184] This illustration is based on van Fraassen's example (1980, 17).
[185] In the event that future technology allowed us to transport buildings as large as the Empire State Building, then it would become permissible to call the latter "portable"; such a shift, however, is entirely consistent with van Fraassen's point. A few centuries ago, people did not describe small huts or cottages as portable, but now we legitimately call portable pre-fab buildings and trailer homes, which are of comparable size.

Observability, whilst relative to the capabilities of humans, is based upon empirical evidence and to assert that something is observable is therefore to make an objective claim, which in turn takes a truth-value. Where evidence is observable, we are dealing with facts, and are therefore permitted to commit to the truth of those facts (where phenomena are observable, the categories “empirical adequacy” and “truth” converge). Where we do not have observable evidence of phenomena, then we should abstain from inferring the presence of unobservable objects, precisely because nothing about the data requires us to commit to the ontological reality of such entities.[186]

Such a definition of the observable/unobservable distinction, van Fraassen explains, nonetheless preserves objectivity (Van Fraassen 2003, 411). The facts of science themselves (which arise from empirical discovery) determine what is observable; consequently, humans are given increasingly sophisticated means by which to observe data. Observability is therefore context-dependent to an extent, but not theory-dependent, because what is observable is given directly from the empirical evidence as a fact (Monton and van Fraassen 2003, 409-11); c.f.: (van Fraassen 1980, 57). In other words, no inference is made *from* the theory, but nonetheless, observability is proved empirically by the data.

Another reason for the objectivity of the definition of the observable is that observability rests on scientific evidence, rather than modality, according to van Fraassen (Monton and van Fraassen 2003, 414). Furthermore, although observability varies according to the development of scientific discovery, objectivity is preserved because once a means of measurement is established, then objective observations may be made. In explaining the objectivity of the observable/unobservable distinction, van Fraassen also commits to the idea that the term “observable” refers to all possible instances where observation could take place, and not merely those instances where something is observed in actuality. Within a given epistemic context, once the new means of observation is established, there need be no subjective element to what we call “observable” (a microscope, for instance, works

[186] For instance, ‘[i]t is often not at all obvious whether a theoretical term refers to a concrete entity or a mathematical entity’ (van Fraassen 1980, 11).

at a particular fixed resolution). So although the observable is context-sensitive, it is not contingent on the observations that happen to be made.

According to constructive empiricism, it is because of the nature of observability (as described above) and because of the empiricist commitment to no more than the available evidence, that the aim of a scientific theory is to "save the phenomena" where observable phenomena are available, but not to express any *truth* about the world nor to carry the 'metaphysical baggage' of additional unobservable entities (van Fraassen 1980, 68). To put it another way, '[s]o far as empirical adequacy is concerned, the theory would be just as good if there existed nothing at all that was either unobservable or actual' (ibid., 197). In other words, a theory is precisely as good as it is, at capturing the relevant phenomena, irrespective of whether or not we choose to frame the theory with additional explanations; positing additional entities would not increase the degree to which the theory fits the evidence.

According to van Fraassen, however, constructive empiricism already compromises with the strict empiricist position; a stricter form of empiricism would not permit any assertions wherein the content is not restricted to that which is shown by available evidence. As Van Fraassen points out, even a commitment to 'empirical adequacy goes far beyond what we can know at any given time' (van Fraassen 1980, 69), according only to the gathered data. In other words, a set of data just is a set of data, and even a theory that aims for empirical adequacy makes inferences away from the data, in its descriptions; anything beyond a reproduction of the data entails an inference of some sort (Ladyman and Ross 2007, 103). Van Fraassen's position is nonetheless grounded in the epistemic modesty of his empiricist commitments, whereby he resists making claims any further than the evidence allows, as far as possible, whilst also retaining the continued aim towards developing an epistemology of science. The modesty inherent in such a balance is illuminated when van Fraassen explains that an 'epistemology must carefully investigate the conditions of rationality for acceptance of conclusions that go beyond one's evidence. What it cannot provide … is rationally compelling forces upon these epistemic decisions' (van Fraassen 1980, 72-3). Constructive empiricism may consequently be described as a compromise between the investigative modesty of empiricism, and the aim towards an account of the rationality of scientific progress, found in scientific realism (Monton and van Fraassen 2003, 407).

6.3.3. Understanding scientific rationality

The view of scientific theories, according to constructive empiricism, may be characterised to an extent within the terms of RKN. The model of scientific rationality endorsed by RKN turns upon the relativity of mathematical and lawful (i.e., mechanical) principles, which are supplied by the respective constitutive framework (c.f.: chapter 3, §3.3-3.4). According to RKN, therefore, we may understand the terms and laws of a theory as principled yet potentially revisable constructions, rather than ontologically real phenomena or entities. Newton, for instance, defined gravity mathematically, as a formulaic construction according to the laws of motion and with no underlying entity posited as an explanation. Furthermore, the laws of motion themselves were, in turn, built from mathematically defined concepts, such as mass and force. Special relativity also describes phenomena mathematically; space and time no longer constitute absolute concepts, but are defined relative to the speed of light. Objectivity is supplied by SR purely mathematically, by virtue of the invariance of the transformation equations (c.f.: chapter 3, §3.3.2 and §3.4.2). According to the three tier theoretical structure, therefore, the constitutive framework (the components of which are revisable but necessary for the respective theories) provides the foundations for the empirical theory itself, and to that extent, RKN supplies a detailed view of scientific theories grounded on a mathematical basis rather than upon the existence of unobservable entities.

The notion of such a constitutive framework for a given theory is also consistent with investigative modesty. The epistemological motivation for the constitutive-framework model of scientific theories is precisely the fact that we cannot take our current theories and principles to be fixed and unrevisable. No concepts are given which demand the status of “unobservable phenomena”; certain phenomena or theoretical concepts are defined by the constitutive framework, but are defined mathematically, without any additional metaphysical status. Such mathematically defined theoretical constructs are formulated precisely to work to the service of what the evidence demonstrates; the framework is therefore consistent with the empiricist's commitments. For instance, the construction of theoretical concepts according to a particular set of mathematical presuppositions and mechanical laws is comparable to van Fraassen's assertion that, '[b]y means of instruments we *create new phenomena*' (van Fraassen 2006a, 284). According to the stage of scientific development, new theoretical constructs, or new scientific technologies, make it possible for us to observe new phenomena, or to conceive of certain phenomena framed in a new conceptual way; in both cases, the present state of scientific understanding (whether in terms of the instruments produced, or the underlying conceptual framework) determines the sort of constructs or phenomena into which we are able to inquire. In accordance with naturalism, RKN brings no metaphysical demands or doctrines to inquiry, and no metaphysical status is implied for the theoretical concepts; such an approach remains consistent with the approach endorsed by van Fraassen, whereby the philosopher should refrain from metaphysics, allow science take the lead, and abstain from committing to the existence of unobservable objects.

It appears, upon the above considerations, that whilst RKN does not strictly entail constructive empiricism, it might offer a supportive framework for the scientific rationality of such a position. In other words, with respect to the features considered so far, RKN might be used in order to speak in favour of constructive empiricism. One might wish to construct the following argument. Since RKN has been defended as a legitimate model of scientific rationality, and given that its features emphasise certain aspects of constructive empiricism, the legitimacy of RKN might look like a means by which to strengthen the case for constructive empiricism.

6.3.4. Resistance to metaphysics

Van Fraassen's refusal to allow 'inflationary metaphysics' into his epistemology (1980, 73) entails a rejection of objective modal claims as components of any account of scientific rationality. The rejection of modality may be construed as further evidence of van Fraassen's continued epistemic modesty. Any commitment to the reality of unobservable entities constitutes a modal claim (for instance, in any assertion that such entities “must exist” or “probably exist”), and modal claims introduce the sort of metaphysics that van Fraassen wishes to avoid, as they propose ideas which extend beyond the given empirical data. In other words, empirical claims allow us to make assertions about certain contingent states of affairs; modal claims are logical (and not contingent) assertions, and therefore necessarily express content which is additional to whatever is empirically indicated.

According to constructive empiricism, simply the appearance of regularity within the data we collect does not license modal metaphysical claims about the necessity of lawful generalisations (i.e., modal explanatory claims about the empirical evidence). To assert that a generalisation must hold across any part of the universe, or of a specified domain, and to make that assertion as a claim about the truth of the world, is to commit to a modality which is not warranted by the evidence. As a result, commitment to the truth of such an assertion constitutes precisely the sort of metaphysical baggage that van Fraassen wishes to avoid. Science itself may provide an explanation of cohesion, unity and simplicity, but this is not for the philosopher to do:

> an empiricist account of science must involve throughout a resolute rejection of the demand for an explanation of the regularities in the observable course of nature, by means of truths concerning a reality beyond what is actual and observable, as a demand which plays no role in the scientific enterprise.
> (van Fraassen 1980, 203).

Such a “resolute rejection” of generalised explanations is the reason that the notion of the unity of science, as a regulative ideal, stands in conflict with constructive empiricism (ibid., 83). Van Fraassen concedes that the idea of unity persists within the practice of scientific inquiry; his point, however, is to emphasise that such notions are not the concern of the empiricist. In other words, science should be left to resolve such issues, and the philosopher should stand well clear; as van Fraassen himself explains, ‘[p]hilosophy of science is not metaphysics’ (ibid., 82).

Instead, van Fraassen insists, modal relations are linguistic or logical issues which have been mistaken for issues about the objects of inquiry and the content of scientific theory (ibid., 196). Modal assertions, such as theoretical propositions about probability, are nonetheless widely employed within science (as van Fraassen readily concedes). One may understand this by realising that we take on the language of modality as a pragmatic activity, but not as a metaphysical commitment; once a theory is accepted we talk as though such a theory is true, simply for the sake of convenience (van Fraassen 1980, 202).

Upon the acceptance of a theory, there is an inherently modal character to the way in which we talk about the claims given within that theory, but such talk just reflects the practical use of a certain means of expression, much in the same way that we might accept a theory on the basis of pragmatic motivations, without committing to its truth.[187] Observability need not be regarded as a modal claim either, according to van Fraassen; there may be an apparent conditional claim about what is observable but this has only a relative, context-dependent truth value, rather than an absolute truth value. As such, claims about observability may be deemed objective whilst only nominally modal; just as is the case for all other modal expressions within scientific talk, the modality of observability-claims is purely nominal, taken up pragmatically within scientific discussion or communication. The practical acceptance (without commitment to the truth) of modal claims is what van Fraassen refers to as modal nominalism (Monton and van Fraassen 2003). In other words, theory-acceptance:

> has a pragmatic dimension: it involves a commitment to confront any phenomena within the conceptual framework of the theory … [and] the language that we talk has its structure determined by the major theories we accept. That is why, to some extent, adherents of a theory must just talk as if they believed it to be true.
> (Van Fraassen 1980, 202).

6.3.5. The possibility of a defence of constructive empiricism

Because of the practicality of this way of talking, the dismantling of the acceptance of a theory involves changes to our language, and this is why it may often be referred to as a ‘conceptual breakdown’, leading to a ‘conceptual revolution’ (ibid., 202). But because we are able to use language in a reasonably sophisticated way, the truth is

[187] In other words, ‘modal predicate terms [do not] have to stand for modal properties’ (Monton and van Fraassen 2003, 411).

that scientists are not thrown by the adaptation to theory-laden language, according to van Fraassen (ibid., 202). Again, whilst RKN does not entail constructive empiricism, it remains consistent with such a pragmatic aspect of theory change. As constitutive frameworks change, so does the conceptual language; but this needn't mean that we are prevented from meaningfully changing from one constitutive framework to another. Ontological discontinuity, and conceptual "breakdown", need not pose a problem for either RKN or constructive empiricism. The ideas provided by a constitutive framework needn't require a commitment to entities which might not be continuous over theory change; if mathematical constructs are given instead of unobservable entities, no metaphysical commitment is made and therefore no ontological difficulty is created. The issue remains of negotiating the various shifts in meaning, but as van Fraassen points out, our use of language is sufficiently sophisticated so as to allow for such linguistic alterations.

The consistency between RKN and constructive empiricism is continued in van Fraassen's concession to the fact that scientific theories track structure, and that such structure may be preserved across theory change. According to constructive empiricism, we are permitted to commit to the mathematical structures of theories (because no unobservable phenomena are necessarily entailed by structure), which point is drawn out in van Fraassen's empiricist structuralism (van Fraassen 2006a; 2007). Such a structuralist position embodies all the same doctrines of constructive empiricism, with a more explicit concession to the steady accumulation of scientific knowledge of structure (Van Fraassen 2006a, 297). Mathematical structures, therefore, may join observable phenomena in the set of 'things we deal with directly' (ibid., 197).

Even so, whilst acknowledging scientific continuity, Van Fraassen nonetheless cautions against excessively generalising over theoretical developments (again, commitments to the truth of modal generalisations about theory change would not be permitted). Aspects of continuity have been selectively emphasised, according to van Fraassen, and the appearance of theoretical continuity 'come[s] from extremely selective attention to certain features of the old theory, whose relevance is only identifiable retrospectively, so as to function in retrospective rationalisation' (Van Fraassen 2006a, 300-1).[188] Whilst there are many characteristics of empirical structuralism which converge with those of ontic structural realism, as I shall emphasise, van Fraassen still resists making claims about underlying explanations for theory change (for example, any explanatory generalisations made via modal claims about unity).

The constructive empiricist rejection of metaphysical baggage is founded upon the epistemic modesty inherent to van Fraassen's commitment to empiricism. I have demonstrated, in chapter 5, that the Regulative Boundary (RB) functions as a means by which to draw out the naturalist commitment to epistemic modesty, and to subsequently guide philosophical proposals accordingly, in a way which combines such modest, with both the optimism of inquiry (which is desirable within a naturalistic position), and the regulative ideal of scientific unity. The RB might therefore be put to similar use for constructive empiricism. In light of the consistency between the model of scientific theories according to RKN, and the features of constructive empiricism (detailed above, §6.3.3), one might wish to argue that the RB may be brought in to strengthen the constructive empiricist, or empirical structuralist, foundations of epistemic modesty upon which modal claims are rejected.

The RB itself, however, amounts to a modal claim about the principle of unity, even as a regulative ideal. In upholding a unity principle, we both expect and seek out generalisations which hold across all, or significant sub-sections, of the universe, and within counter-factual cases. Unity is demanded in our expectation of such lawful generalisations because without such unity, we would have no reason to believe that generalisations of this sort were possible; furthermore, unity is required as an explanation of the evidently successful application of theoretical generalisations. As a regulative and not constitutive claim, such a principle does not threaten the criteria of naturalism (c.f.: chapter 2, §2.3.2), but the RB is expressly a unity principle of the sort which van Fraassen emphasises must not be the concern of the philosopher. The incompatibility of the RB with constructive empiricism should not be a reason upon which to reject constructive empiricism outright. A problem is

[188] Any continuity is, for van Fraassen, 'somewhat overstated' (van Fraassen 2006a, 301).

created, however, by the conflict between the modality of unity and unacceptability of modal claims according to constructive empiricism. In the following section, I shall proceed to my argument that RKN usefully illuminates the claim that ontic structural realism should be favoured over constructive realism.

6.4. Ontic structural realism and the unity of inquiry

6.4.1. Ontic structural realism

So far I have explained the merits of constructive empiricism (or empirical structuralism), and have offered an idea of how RKN might potentially lend support to the position; the valuable features of constructive empiricism are found in the insistence that scientific practice should lead philosophy, in the shift in focus from objects to structure, in the naturalistic resistance to excessive metaphysics whilst pursuing the aim of accounting for scientific rationality (especially in light of the challenges posed by theory change), and in the inherent epistemic modesty. I have demonstrated in §6.3 that all such common features are exhibited by constructive empiricism, and reinforced by RKN. In the present section I shall argue that ontic structural realism should be favoured over constructive empiricism because the former retains all of the beneficial characteristics of the latter, whilst offering an additional insight not upheld by constructive empiricism (namely, the recognition of modal propositions, and subsequently the notion of the unity of science). I shall demonstrate that, whilst such an argument is independently possible, the defence is usefully and uniquely strengthened by the use of RKN (specifically, with the application of the RB).

The above proposal is not intended as an argument for the rejection of constructive empiricism, nor for the claim that ontic structural realism necessarily relies upon RKN for a successful defence. Instead, I wish to demonstrate two main points.

1) First of all, the preference for ontic structural realism over constructive empiricism is uniquely and helpfully strengthened by RKN because RKN draws out those core areas in which ontic structural realism and constructive

empiricism are in accord.[189] Such a defence therefore upholds and emphasises the merits of constructive empiricism, whilst demonstrating that ontic structural realism has important additional benefits which are not given by constructive empiricism.

2) RKN emphasises the argument for the favouring of ontic structural realism. Whilst the argument may be given independently, RKN offers a unique support, via the application of the RB, which in turn highlights the interconnection between the metaphysics of unity, the importance of epistemic modesty, and the investigative optimism (as well as the respect for scientific practice) characteristic of naturalistic inquiry. In other words, the RB additionally respects and underlines the benefits of constructive empiricism (as noted in point one, above).

Essentially, the second point may be alternatively given as the claim that although ontic structural realism does not depend on the support of RKN, the RB actually embodies the notion of unity which is inherent to ontic structural realism. To this extent, a certain quasi-Kantian characteristic is illuminated within ontic structural realism. In order to advance my argument, in this sub-section I shall detail the ontic structural realist position, with regard to science in general.[190]

In contrast to epistemic structural realism, ontic structural realism does not focus on our knowledge of structure; instead, the approximate truth of scientific theories is explained by appeal to the idea that it is not unobservable entities, but structure, which is real. As such, no unobservable phenomena are posited, which feature is entirely compatible with constructive empiricism. The ontological discontinuity of unobservable entities, to which previous theories would supposedly have us commit (upon a realist construal), undermines the scientific realist's explanation for why science is not miraculous (Ladyman 1998, 417). Only structure, therefore, may be regarded as real, and what scientific theories latch on to are these real structures, *qua* the truth about the reality of the world. Both the difficulties

[189] Those such as Ladyman and Ross (2007) pay great respect to the benefits of constructive empiricism throughout their defence of ontic structural realism. C.f.: (Ladyman 2000; 2004).
[190] I shall follow the ontic structural realism frequently endorsed by Ladyman, with large reference to the arguments given by Ladyman and Ross (2007); c.f.: (French and Ladyman 2003a; 2003b); (Ladyman 1998).

arising from unobservable entities, as well as the ontological discontinuity that occurs with theory-change, are avoided by an appeal to the reality of structure. As Ladyman and Ross put it:

> structural realism is the view that our best scientific theories describe the structure of reality, where this is more than saving the phenomena, but less than providing a true description of the natures of the unobservable entities that cause the phenomena.
>
> (Ladyman and Ross 2007, 67).

What is real in the world is precisely just structure; we may expect our best science to latch on to the truth of such structure, as an explanation of why scientific success is not miraculous. Such an ontological commitment is motivated by the scientific theories of physics, rather than assertions within philosophy, in accordance with the requirements of naturalism. Put otherwise, '[t]he history of science undermines not only materialism … but also the claim that science describes the individuals that lie beyond the phenomena' (ibid., 256).[191]

What is taken to be the truly astonishing achievement of science (and therefore, the factor most likely to be viewed as miraculous) is the successful novel predictions afforded by scientific theories. Ontic structural realism may be characterised as:

> the view that the world has an objective modal structure that is ontologically fundamental, in the sense of not supervening on the intrinsic properties of a set of individuals … [E]ven the identity and individuality of objects depends on the relational structure of the world.
>
> (ibid., 130).

The central tenet is that if a unified structure can be established, whatever this structure turns out to be, 'then successful applications of particular instantiations of these structures in new domains, so as to generate novel but reliable predictions, will be explicable and non-mysterious' (ibid., 74-5). In other words, if science is to be deemed non-miraculous we need to account not only for the scientific success of theories *per se* but also for their capacity for successful novel prediction in some cases. The extension of the scope of a theory requires a degree of accuracy which

---

[191] Such a thesis about the non-fundamental nature of individuals is defended throughout the arguments for ontic structural realism. See especially: (Ladyman and Ross 2007, chapters 3-4).

goes beyond what has been observed and recorded by us, precisely because the theory with novel predictive success explains more than it was designed to explain. So, 'the real miracle about the success of science is not empirical success in general, but how it is that scientific theories can tell us about phenomena we never would have expected without them' (Ladyman and Ross 2007, 75). In order to account for such an occurrence, ontic structural realism endorses the idea that theories *do* latch on to the truth about the reality of the world, where such reality is just structural.

The claim that scientific theories track the truth about structural reality should be clearly distinguished from the claim that we *know* the real structure in question. We have no guarantee that our current best scientific theories represent real structure in the most directly accessible way. The idea instead is that our best theories latch on to the real structure to some degree; this structure will persist over theory change, because whatever element of real structure is tracked in the initial theory will be preserved within the degree to which real structure is represented within the updated theory. In other words, the degree to which a theory is successful indicates the degree to which it must latch on to the true structure of the world (*qua* what is real). Such a claim doesn't guarantee epistemic certainty of the particular structural details (for instance, we may not be able to tell at a given stage, which elements of a theory represent the ontologically real structure) but it does guarantee that the truth-tracking ability of science is preserved even in the face of drastic changes to theoretical concepts. Ontic structural realism therefore upholds a great deal of epistemic modesty (it licences no premature epistemic claims) but not at the expense of investigative optimism about the possibility for an explanation of scientific success.

Aside from a stronger commitment to the truth of what is real (as opposed to mere empirical adequacy), constructive empiricism and ontic structural realism may appear very similar according to the description so far. The aim of constructive empiricism is to 'offer a positive account of science that is intended to vindicate its rationality and its cumulative empirical success' (Ladyman and Ross 2007, 76), which is precisely what ontic structural realism seeks to do as well. Constructive empiricism does, in fact, concede to the structural relations preserved by scientific theories (van Fraassen 2006), and in fact, Ladyman and Ross 'stress that … [they] do not care whether … [they're] deemed better entitled to "empiricist" or "realist" party cards' (Ladyman and Ross 2007, 304).

In van Fraassen's objection to the use of inference to the best explanation, within the no-miracles argument, he does not reject realism because of any claim that it is irrational (ibid., 98 and 107). Van Fraassen merely points out that scientific realism is not necessarily compelling, and that it is just as rational to decline to accept it, which van Fraassen wishes to do, so as to avoid the metaphysical commitments of the scientific realist position.[192] If ontic structural realism allows a form of the no-miracles argument, but without the objectionable metaphysical trappings, perhaps the difficulty is removed for the constructive empiricist. Ontic structural realism allows no less epistemic modesty, in its commitment to upholding scientific work before philosophy, the difficulties of theory change are also accounted for, and the existence of unobservable phenomena is not endorsed, all of which features are consistent with constructive empiricism.

With such similarities in mind, one might wonder why it should be that ontic structural realism has anything to offer, over and above a constructive empiricist position. The debate, however, turns upon the issue of modality, or in other words, the commitment to unity (which instantiates a modal claim) on the side of the ontic structural realist, and the resistance towards modal claims (which amounts to a resistance towards the very notion of unity) on the side of the constructive empiricist. I shall spell out the argument for why constructive empiricism entails modal commitments after all.

6.4.2. The reality of structure

Structure is not given ontological primacy purely for the sake of avoiding the difficulties raised for unobservable objects, or ontological discontinuity; ontologically real entities and individuals are rejected on the basis of what our best physics tells us. The ontic structural realist view is that no individuals subsist as real entities: individuals are, instead "book keeping" devices for the structures which are

[192] For more on what van Fraassen deems to be rational in terms of theory acceptance, see: (Ladyman and Ross 2007, 103-6).

real (Ladyman and Ross 2007, 121 and 229). In other words, structures do not depend upon individuals but instead, 'individuals are resolved out of patterns rather than vice versa' (ibid., 229). Such a characterisation of individuals is introduced because it appears that, at least according to some theses in fundamental physics, the notion of individual entities is undermined.[193]

Different theories in physics also motivate alternate claims about the respective possibility for a universe which may or may not have a fixed temporal direction. Causality poses a problem for certain areas of modern physics, and 'it is an open question whether there is an objective global asymmetry in time' (Ladyman and Ross 2007, 172).[194] Because of the debate about whether or not causality is fundamental, and because causality seems to rely upon a particular temporal direction, endowing causality with a fundamental role should be avoided, in order to remain compatible with PPC (Ladyman and Ross 2007, 210-1).[195] According to the Primacy of Physics Constraint, or the PPC (explained in chapter 2, §2.3.), for any issue which remains undetermined by fundamental physics, ontic structural realism must respect the various possibilities and remain neutral (Ladyman and Ross 2007, 162 and 211; c.f.: ibid., chapter 3).

Whilst the theories of physics do not directly or necessarily entail a rejection of 'distinct ontologically subsistent individuals with intrinsic properties' (ibid., 154), such theories do not readily imply a distinct metaphysical status for individual entities, so that the burden of proof is placed on the philosopher who wishes to endorse such a metaphysics of ontologically real individuals. Put another way, considering the details of quantum mechanics, the notion of individual entities is

[193] There is some worry, within the literature, about the notion of discarding individual entities, and ontic structural realism comes under criticism for this reason, for instance, in: (Cao 2003a; 2003b); (Chakravartty 2003; 2004). C.f.: (Psillos 2001; 2006). Defence against such objections is offered, however, by French and Ladyman (2003a); c.f.: (French and Ladyman 2003b); (Ladyman 2007); (Ladyman and Ross 2007, 148-154). A consideration of this issue is also given from the perspective of empiricist structuralism by van Fraassen (2007).

[194] For further discussion of these issues with relation to what is indicated by various theories within physics, see: (Ladyman and Ross 2007, chapter 3, especially 159-189). For a specific discussion of causation, see in addition: (ibid., chapter 5).

[195] The issue of causality is spelled out with reference to physicalist conceptions of mind in Ladyman (2008), in which the so-called problem of mental causation is dissolved. For more on the very notion of causality within the sciences, see: (Norton 2007).

thought to be undermined at a fundamental level (Ladyman and Ross 2007, 195); as such, various aspects of quantum gravity indicate:

> that one way or another the world is not going to be describable at the fundamental level by means of the familiar categories from classical physics that derive from the common-sense world of macroscopic objects … Thus it appears overwhelmingly likely that some kind of mathematical structure that resists domestication is going to be ineliminable in the representation of the world in fundamental physics.
> (ibid., 172).[196]

The ontological reality of individuals is done away with completely. So far, such a move is consistent with constructive empiricism; but the reality of structure is bound up with the notion of objective modality and unity in science. In other words, it is precisely the objective modality of the novel predictive success of theories which goes towards explaining the reality of structure.[197]

As Ladyman and Ross put it, 'ontic structural realism ought to be understood as modal structural empiricism, and that this view can claim all the advantages of constructive empiricism and scientific realism without being prone to the problems that those views respectively face' (Ladyman and Ross 2007, 99); c.f.: (ibid., 101). On the basis that the history of science shows us that scientific theories offer support to counter-factual claims, and generate (on occasion) successful novel predictions, then the course of scientific inquiry and discovery indicates that the world most likely consists of objective mind-independent modal relations. In other words:

> If science tells us about objective modal relations among the phenomena (both possible and actual), then occasional novel predictive success is not miraculous but to be expected … Provision of these explanations is not a matter of satisfying philosophical intuitions, but of unifying scientific practices and theories … [W]e are [therefore] motivated … to take seriously the positive thesis that the world is structure and relations.
> (ibid., 154).

[196] C.f.: (Ladyman and Ross 2007, 132 and 229).
[197] The unity in science is derived by Ladyman and Ross from the commitments of science itself, because unity is 'exemplified in the actual history of science' (2007, 27).

As such, the notion of unity in science and the objective modality which necessarily accompanies such unity, are both motivated by the theories of science themselves.

6.4.3. Structure in the special sciences

Objective modal structure, *qua* that element of the world which is real, may be thought to persist across theory change because ‘in the history of science ... all the well-confirmed modal relations expressed by old theories are approximately recovered in their successors’ (Ladyman and Ross 2007, 123).[198] The special sciences frequently seem to benefit from the use of self-subsistent individuals, and so, if ontic structural realism is to work, some possibility for unification must be found between the fundamental and non-fundamental sciences. It is useful at this stage to review the definition for fundamental and non-fundamental sciences. Essentially, those scientific fields which observe phenomena and gather data at restricted or localised levels of the universe are non-fundamental. In other words:

> a science is special iff it aims at generalizations such that measurements taken only from restricted areas of the universe, and/or at restricted scales are potential sources of confirmation and/or falsification of those generalizations … [As] there are only special sciences and fundamental physics … the overwhelming preponderance of scientific activity is special-scientific activity.
> (ibid., 195).

I will provide only brief detail on the sort of structure proposed by ontic structural realism because, given the similarities between the two positions, the notion that it is structure which is captured by theories is not an area of disagreement between them, and therefore not an area relevant to the particular argument at hand. The particular details of the structure have been spelled out with regard to both fundamental and non-fundamental sciences (ibid., chapters 3-4). Because the account of structure within the special sciences usefully illuminates the way in which ontic structural realism accounts for the unity of real structure across all sciences, and not just fundamental physics, I shall provide an explanation with regard to the special

[198] For a worked example of such structural continuity, see for instance: (Ladyman and Ross 2007, 94).

sciences. I shall use cognitive science as an example case, where possible. A secondary function of the present description is that it usefully accounts for the varying levels of taxonomy, even upon different accounts of the mind. Because of the difficulty with relying upon causation as a fundamental concept, we may think instead of information flow or information transfer (Ladyman and Ross 2007, 210-220); as such, the notion is developed, of the passing of information about patterns.

Real patterns are what exist in the world, and the mathematical or formal structures represent such real patterns. If individual objects are no longer the means by which to identify patterns or structural relationships, it is still possible to refer to the overall pattern which exists (i.e., not merely by reproducing its structural representation).[199] In other words, we may nonetheless:

> [pick] out a real pattern independently of its structural description by an ostensive operation—that is, by "pointing at it" … one indicates the real pattern's *location* in some coordinate system with high enough dimensionality to permit its disambiguation from other real patterns … [We may therefore] speak of all the traditional kinds of objects of reference—objects, events, processes—by mentioning their *locators*.
> (Ladyman and Ross 2007, 121).[200]

A real pattern is given a location, the position of which is held by a "locator"; where we usually talk about objects, events and so on, these may be understood as such locators, i.e., the means by which we point to the location of a real pattern. Individual objects, therefore, are not real but we may still talk about individuals as a pragmatic way of referring to the ontologically real patterns (for which such individuals are locators). The locator allows us to talk about 'operations of fixing, stabilizing, and maintaining salience of data from one measurement operation to another' (ibid., 121).

---

[199] There is concern about the issue of precisely how mathematical structure may represent real structure in the world. For careful and considered examination of such issues, see: (Brading and Landry 2006); (French 2009); (van Fraassen 2006b).

[200] Taking the aardvark as an example of a locator, such a locator 'directs us to take measurements in certain sorts of terrestrial African habitats within a certain range of temporal coordinates, and focussed on certain sorts of behavioural regularities and certain sorts of genetic processes' (Ladyman and Ross 2007, 122).

The 'scale relativity of ontology' (Ladyman and Ross 2007, 199) is a pragmatic thesis by which we may posit individual entities that are relative to a certain scale of description.[201] So scale relativity amounts to:

> the idea that which terms of description and principles of individuation we use to track the world vary with the scale at which the world is measured … [For example:] at the quantum scale there are no cats; at scales appropriate for astrophysics there are no mountains; and there are no cross-elasticities of demand in a two-person economy.
> (ibid., 199).

Put otherwise, individuals may be thought of as 'epistemological book-keeping devices' (ibid., 240), place markers which hold practical use in our identification of real structural relations at a given scale of measurement.

Locators identify a given pattern, and patterns in turn are thought to carry information; more specifically, it is information about other real patterns that is carried. Based on the notion of ontological scale-relativity, two types of pattern may be identified: those patterns which depend upon other patterns (because the information they carry is about another pattern), or those patterns which do not depend upon other patterns. Without any metaphysical import, just for convenience's sake, we may think of these as second order and first order patterns respectively:

> let us say that a real pattern is 'extra-representational' if it is not second-order with respect to any other real pattern. Real patterns that are not extra-representational will be called 'representational'. The overwhelming majority of real patterns that people talk directly about are … representational.
> (ibid., 243).

The notion of real patterns formed out of other real patterns supplies an explanation of how the fundamental unity of physics ultimately founds the patterns at other ontological levels, but without committing us to a reductionist view of unification.

The real patterns tracked by the special sciences are spelled out with reference to Dennett's "real patterns" (Dennett 1991), referred to as 'dynamic patterns' (Ladyman and Ross 2007, 201). Focal points, marked by so-called

---

[201] Ontological scale-relativity is a pragmatic tool explicitly endorsed and used by working scientists (Ladyman and Ross 2007, 203-4).

individuals, allow the tracking of a pattern with respect to a given phenomenon; such patterns are what provide the real structure, in order that ontic structural realism may account for structure at the level of description of the special sciences. At a broader, or finer, scale of individuation, however, the phenomenon tracked by the pattern may become undetectable (as would the focal points of the individuals). For example, the theory of natural selection provides generalisations about the patterns of species, where species-types and generations constitute the relevant scale-relative booking-keeping individuals. However, no such patterns of natural selection make any sense if we are dealing with (say) the mating behaviour of one or two generations of lions of a particular pack; whilst the patterns of a broader scale become invisible, this does not lessen their usefulness to the scientific field in which such patterns are studied, and such individual identities utilised (Ladyman and Ross 2007, 203). An understanding of individuals as scale-relative book-keeping devices means that the reality of patterns is not required to be reducible to the structures identified upon smaller ontological scales (ibid., 203).

At the same time, the scale and scope of the patterns for one field of science may be understood as being explained or constrained by the scope of other fields. The demands of the PPC (c.f.: chapter 2, §2.3.2) mean that special sciences must respect what fundamental physics tells us about their potential scope. Physics, for instance, constrains the scope of both psychology and computer science; on a trivial level, for example, the potential scope of the fields of computation, or of psychology, are limited by what physics tells us about the possible forces in the universe, which in turn constrains the scope given to the sort of phenomena included under "the psychological". A psychologist is not permitted to posit cognitive capacities which play an influential role at the same level of the sort of phenomena tracked by a particular area of physics, because if psychological capacities extended into the scale of a given field of physics, we would expect their identification within physical theory and not psychology. In other words, the scope of one field (physics) sets a constraint on the potential scope of another field (psychology). Similarly, computation (defined in the broadest sense) will constrain psychology because the set of all potentially possible computations is not exhausted by the functions of which the human mind is capable. The present point explains Ladyman and Ross's claim that:

> [t]o comment on the scope of a special science from the domain of another special science with which the scope of the first is asymmetrically related is to engage in unification, and that is what metaphysics is about, according to us
>
> (Ladyman and Ross 2007, 210).

We are neither obliged nor permitted to speculate any further than this as to how the precise unification of various real patterns may relate to one another. The notion that real patterns, on a given scale of scientific description, may constitute the very information carried by another real pattern, accounts for how special sciences may retain their unique taxonomy (referring to individuals, where this is a practical requirement) as fields of inquiry which generate explanations that legitimately track the true reality of the world.

The debate about the level of realism given to theoretical entities is especially interesting to the fields of psychology and cognitive science, as little agreement is established as to how we should sub-divide mental phenomena, or as to the ontological status of such phenomena. Given that scientific terms bear no commitment to common-sense notions, we should not expect folk psychological terms to enter into scientific explanation; but opinion varies as to the strength and extent of this idea (Collins 2007, 632, n10).[202] The theories supplied within cognitive psychology are characteristically abstract and, consequently, philosophers are prone to worry about what sort of ontological status should be given to mental phenomena or mental events (c.f.: chapter 2). In addition, given the relative infancy of the field of cognitive psychology (compared to physics or chemistry, for instance), cognitive scientists are still very much in the process of deciding what theoretical constructs should be posited, how we should "carve" the natural domain, etc. (c.f.: chapter 5). A given theory of cognitive science, therefore, may be taken to track the truth of the world, *qua* real structure. Ontic structural realism doesn't tell us which theory is *correct*, but such an account of the structure of theories of special sciences both legitimises the notion of a non-reductive scientific unity, as well as their capacity for capturing the reality of the world.

[202] Pylyshyn also endorses the idea that our common sense understanding of mental categories shouldn't determine the way in which we specify categories for inquiry; even so, he leaves room for the possibility that certain pretheoretical notions might have something important to show us (Pylyshyn 1984, 263-72).

6.4.4. Cassirer, structure and unity

Ontic structural realism commits to the representation of real patterns via structures given by theories formally or mathematically (Ladyman and Ross 2007, 119). It is precisely such mathematical and structural constructs which are endorsed by Cassirer, and subsequently by RKN. Concepts of theories are mathematically defined and therefore express structural relations rather than individual entities. This is precisely why RKN entails no unobservable objects; for the same reason, RKN is entirely consistent with the rejection of ontologically real individual entities, because the rationality of theories and of theory change are explained with reference to the constitutive framework (Cassirer 1910/2003, 115-6). Furthermore, the RB supplies the unit against which principles are understood as relative, as well as the unification by which the modality of scientific theories is explained.

The modality afforded by the unity at the basis of scientific theorisation (i.e., the unity provided by the RB) is made explicit by Cassirer throughout his examination of the structure inherent in scientific theories,[203] when he explains the presupposition essential to scientific theories that the universe is structured in a unified, uniform manner so that the lawfulness of a theory will adhere with the same necessity throughout the universe (or the relevant specified domain of the universe). He makes explicit the notion that unity is the goal of scientific theories (Cassirer 1921/2003, 373), and explains that both Special Relativity and General Relativity uphold such unity as an epistemological demand (ibid., chapter 5). As already explained, the RB is precisely an instantiation of Cassirer's principle of unity (c.f.: chapters 3 and 4).[204]

---

[203] (Cassirer 1910/2003; 1921/2003). French and Ladyman (2003b) explicitly recognise that ontic structural realism shares Cassirer's aim to discard ontological commitment to individuals in favour of an ontology 'more suited to twentieth-century science' (Ladyman and Ross 2007, 132). Ladyman and Ross (2007, 140), for instance, cite Cassirer's description of the field in terms only of structure, and the electron not as an individual, but only with relation to the structuralist construal of a field (Cassirer 1936/56, 178).

[204] Cassirer also emphasises the notion that the regulative ideal of unity is necessary for scientific theories, and their application, as an explicit explanation for why it is that finding order in nature is so much as possible and for why it is that scientific inquiry makes the achievements that it does (Cassirer 1918/81, 293-4).

6.5. Modality and metaphysics

Despite the constructive empiricist's rejection of the metaphysics of modality, constructive empiricism nonetheless entails an implicit commitment to modal claims (Ladyman and Ross 2007, 99), beyond the nominal modality to which van Fraassen concedes. Even if we conceded to van Fraassen's claim that empiricism does not place a premium on experience *per se*, the commitment to empirical evidence is itself not justifiable upon purely empirical grounds (Ladyman 2000, 845).

Modal claims are about logical relations rather than physical necessities or possibilities, according to van Fraassen, but Ladyman argues that 'he ought to be positively committed to there being objective relations between the actual and the possible whilst this is something he explicitly rejects' (Ladyman 2000, 849); c.f.: (Ladyman and Ross 2007, 107). We may take observable facts to be true, given that we have direct access to the supporting evidence; van Fraassen makes clear that it is not the language of the observable/unobservable, but the empirical results of science, which demarcates the observable/unobservable distinction with reference to what is observable-to-us. Such a demarcation from science is thought to be empirical but theory-independent; but such results are dependent themselves on whichever theory we choose to adopt, and so it looks after all as though the definition of observability is a modal claim after all (Ladyman 2000, 848-52); (Ladyman and Ross 2007, 111). Van Fraassen tries to account for counter-factual statements of the form, "if *x* was present, it would be observable", by reframing them as claims of the following type: no physically possible world exists where *x* is present, and where we are unable to observe *x* (Ladyman 2000, 851). Such reformulation, however, as Ladyman points out, 'just reduces to the logical necessity of the conditional that has the laws of nature conjoined with the relevant class of initial conditions as antecedent, and our observing [*x*] … as consequent' (ibid., 851); c.f.: (Ladyman and Ross 2007, 109). In other words, in its paraphrased form, van Fraassen's construal of the counterfactual still amounts to a modal claim.

The fact that van Fraassen wants observability to remain theory-independent, so as to retain objectivity, means that he is essentially looking for a principled account (Ladyman and Ross 2007, 108). Such a principled account (as ontic structural realists argue) is precisely the sort of objective modal claim that is inherent within scientific theorising. Ladyman and Ross base the notion of the unity in physics and other sciences in the very practice of science itself. As already demonstrated (c.f.: chapter 3) Einstein provides an example of a physicist who explicitly upholds and seeks out the notion of unity in science. The RB is developed in line with a commitment to what is demonstrated by science, given the naturalism of RKN, but is also grounded in a specifically Kantian notion; it is, therefore, developed specifically as a regulative notion, but one which is upheld within science. The RB instantiates a regulative boundary which binds together both epistemic modesty and investigative optimism with the ideal of the unity of science (c.f.: chapter 5). Such unity would be evident in an ideally completed science, but may also be thought to permeate any given stage of scientific inquiry and any theory-relative scientific principles, precisely because the boundary supplies that unifying factor according to which we may conceive of a coherent totality of completed science at all, and by which we understand the unity, and uniformity, of the application of scientific theories across vast sections of the universe, and even for the prediction of phenomena we did not anticipate.

Ladyman concludes from such points that ‘although the constructive empiricist need not be committed to the full truth of theories to demarcate the observable, she is committed to belief in some of their modal implications’ (Ladyman 2000, 851); c.f.: (Ladyman and Ross 2007, 109). So, even if we settle for empirical adequacy, the observable is theory-dependent after all, and therefore certain modal implications follow, about the counterfactuals of observability.

Another point is that modality actively enters into scientific inquiry, beyond mere practical convenience. Theories are generated which provide generalisations about what it is possible to observe, and not what just happens to be observed:

> theories are always modalized in the sense that they allow for a variety of different initial conditions or background assumptions rather than just the actual ones … [and] no observable phenomena could allow us to distinguish in our epistemic attitude between theories that agree about everything that

actually happens, but disagree about what would happen under possible but counterfactual circumstances.

(Ladyman 2000, 852).

In other words, the qualities of novel prediction and support for counter-factual claims are modal; c.f.: (Ladyman and Ross 2007, 110).

It seems that van Fraassen is motivated in part by a desire to adhere to an epistemic modesty, in part by a resistance towards unnecessary philosophical clutter (or "inflationary metaphysics"),[205] and finally by the thought that constructive empiricism best explains the success of scientific practice. Once one understands, however, that some objective modality is actually going to be inevitable if constructive empiricism is to remain consistent, then one no longer has the objection that such claims constitute superfluous metaphysics. Because objective modality cannot be avoided, such claims are rescued from being categorised as "metaphysical baggage". Likewise, no sort of epistemic claim is made in ontic structural realism of the type van Fraassen wishes to avoid (e.g., of unobservable entities); ontic structural realism precisely gets out of the sort of referential difficulties one might be worried about. The importance of modality, and the demand for the principle of unity, is drawn out by holding up the RB to both ontic structural realism, and constructive empiricism respectively, precisely because the RB just is an instantiation of such unity and therefore of the modality that is demanded of and sought within scientific theories.

The constructive empiricist may still decline to concede to the full ontic structural realist position, but the point remains that ontic structural realism achieves the full benefits of constructive empiricism, whilst additionally accounting for the success of novel prediction, the objectively modal structure of reality as well as the underlying notion of unity within scientific theories (for which constructive empiricism provides no account). All such features are precisely embodied in the RB. Because of this, the better account would seem to be ontic structural realism, precisely because the latter matches the benefits of constructive empiricism along with additional important insights.

[205] C.f.: (van Fraassen 1980, 73).

Both constructive empiricism and ontic structural realism carry a strong epistemic modesty; they both overcome the difficulties of theory change, account for the rationality and success of science, and resist making any commitment to unobservable phenomena. In addition, the objective modality inherent in what may be taken as the real structure of the world is accounted for by ontic structural realism, but not by constructive empiricism. Although both positions share several important features, only ontic structural realism incorporates the notion of the unity of science, and objective modality, and therefore has greater explanatory value. As such, ontic structural realism may be considered a better account of scientific rationality and of the success of science. Such a principle of unity, in the form of a boundary notion (i.e., the RB) supplies the unity sought after in the formation of theories, and drawn upon to explain the modality of theoretical generalisation. The foundational role of ideal unity is precisely that notion for which Cassirer argues.

6.6. Conclusion

I have demonstrated that ontic structural realism may be favoured over constructive empiricism; I have also demonstrated that the definitive character of the RB provides a unique and illuminating way in which to add support to this argument. Ladyman and Ross (2007, chapter 6) state that ontic structural realism is a specifically non-Kantian position, by which they mean that ontic structural realism does not endorse any notion of some "noumenal realm", or noumenal "objects" (the reality of which we cannot know), or any idea that the fundamental structure of the world must be illusively hidden as though it is a noumenal object or property. In that sense, I entirely agree. The arguments offered throughout this thesis, however, demonstrate that in quite another sense, ontic structural realism may be thought of as Kantian in accordance with RKN, whereby the naturalised but Kantian RB precisely embodies the principle of unity (and therefore the commitment to objective modality); the RB therefore bolsters the ontic structural realist thesis in a way which draws together the demand for unity in science, a naturalistic investigative modesty along with an optimism for future inquiry.

Chapter Seven: Conclusion

I have defended what I take to be a properly naturalistic position, and have overcome the various potential difficulties in establishing a naturalised Kantian position. In developing Revised Kantian Naturalism (RKN), I have articulated a modified Kantian position which focuses upon Kant's interest in the constitutive conditions for scientific inquiry, and which has been brought up to date with subsequent developments in scientific understanding.

I have defended RKN as a properly Kantian and naturalistic position, whereby relativized yet constitutive principles, which have their basis in mathematical and formulaic constructs, provide the conditions for the possibility of scientific theoretical explanation. In addition to the constitutive framework, I have explained how RKN also consists of a regulative principle of unity, or the Regulative Boundary (RB). The RB is directly bound up in any given set of constitutive principles, but also persists across theory change. In the discussion of Special Relativity, I emphasise the way in which RKN highlights the elements of continuity across theory change, as well as the way in which unity and the modal nature of lawful generalisations are explicitly presupposed and sought after in scientific theories.

I have defended the notion of the RB in more depth, as a specifically Kantian notion which may nonetheless be brought in line with contemporary science. Making use of the RKN and specifically the RB, I have demonstrated that the RB illuminates the argument against the possibility of a constitutive problem-mystery distinction. Likewise, the RB also usefully supports a defence of ontic structural realism over constructive empiricism. The RB offers such support in both cases, by providing a forceful and unique way of drawing together the notions of investigative optimism and intellectual humility along with the notion of unity and its central importance to the modality of theoretical explanation and the formation of scientific theories. (Similar applications may potentially prove useful for further difficulties raised within the debates surrounding structural realism.) The two applications of RKN, which I have defended in chapters 5 and 6, offer a demonstration of the use and relevance of such an account of scientific rationality.

BIBLIOGRAPHY

Ainsworth, P. M. (2009) 'Newman's Objection.' *British Journal for the Philosophy of Science* 60: 135-171.

Allison, H. E. (2004) *Kant's Transcendental Idealism: An Interpretation and Defense*. New Haven / London: Yale University Press.

Arnauld, A. (1964) *The Art of Thinking* (trans: J. Dickoff and P. James). Indianapolis: Bobbs-Merrill Co.

Baldwin, T. R. (1993) 'Two Types of Naturalism.' *Proceedings of the British Academy* 80: 171-199.

Beiser, F. C. (1987) *The Fate of Reason: German Philosophy from Kant to Fichte*. London UK / Cambridge MA: Harvard University Press.

Bilgrami, A. and Rovane, C. (2005) 'Mind, language, and the limits of inquiry' in J. McGilvray (ed.) (2005) *The Cambridge Companion to Chomsky*, 181-203, 306-307. Cambridge UK / New York: Cambridge University Press.

Bontly, T. (2001) 'Should Intentionality be Naturalised?' in D. Walsh (ed.) (2001) *Naturalism, Evolution and Mind*, 43-60. Cambridge: Cambridge University Press.

Brading, K. and Landry, E. (2006) 'Scientific Structuralism: Presentation and Representation.' *Philosophy of Science* 73: 571-581.

Burge, T. (1992) 'Philosophy of Language and Mind.' *Philosophical Review* 101: 3-51.

Cao, T. Y. (2003a) 'Structural Realism and the Interpretation of Quantum Field Theory.' *Synthese* 136: 3-24.

Cao, T. Y. (2003b) 'Can we Dissolve Physical Entities into Mathematical Structures?' *Synthese* 136: 57-71.

Carey, S. and Spelke, E. (1994) 'Domain-specific knowledge and conceptual change' in L. Hirschfield and S. Gelman (eds.) (1994) *Mapping the Mind: Domain Specificity in Cognition and Culture*, 169-200. Cambridge UK / New York: Cambridge University Press.

Carruthers, P. (2005) 'Distinctively Human Thinking: Modular Precursors and Components' in P. Carruthers, S. Laurence and S. Stich (2005) *The Innate Mind: Structure and Contents*, 69-88. Oxford UK / New York: Oxford University Press.

Cassirer, E. (1910/23/53/2003) *Substance and Function* in E. Cassirer (1923/53/2003) *Substance and Function and Einstein's Theory of Relativity* (trans. W. Curtis Swabey and M. Collins Swabey), 1-346. New York: Dover Publications.

Cassirer, E. (1918/81) *Kant's Life and Thought* (trans. J. Haden, introduction by S. Körner). New Haven / London UK: Yale University Press.

Cassirer, E. (1921/23/53/2003) *Einstein's Theory of Relativity* in Cassirer (1923/53/2003) *Substance and Function and Einstein's Theory of Relativity* (trans. W. Curtis Swabey and M. Collins Swabey), 347-456. New York: Dover Publications.

Cassirer, E. (1936/56) *Determinism and Indeterminism in Modern Physics* (trans. O. T. Benfy, with a preface by H. Margenau). New Haven / London UK: Yale University Press.

Chakravartty, A. (2003) 'The Structuralist Conception of Objects.' *Philosophy of Science* 70: 867-878.

Chakravartty, A. (2004) 'Structuralism as a form of scientific realism.' *International Studies in the Philosophy of Science* 18: 151-171.

Chomsky, N. (1957) *Syntactic Structures*. The Hauge: Mouton.

Chomsky, N. (1959) 'Review of B. F. Skinner's *Verbal Behaviour*.' *Language* 35: 26-58.

Chomsky, N. (1965) *Aspects of the Theory of Syntax*. Cambridge MA: MIT Press.

Chomsky, N. (1968/72) *Language and Mind: Enlarged Edition*. New York: Harcourt Brace Jovanovich.

Chomsky, N. (1971) *Problems of Knowledge and Freedom: The Russell Lectures*. London: Barrie and Jenkins.

Chomsky, N. (1975) *Reflections on Language*. London: Temple Smith, Fontana.

Chomsky, N. (1980/2005) *Rules and Representations*. Oxford: Basil Blackwell.

Chomsky, N. (1986) *Knowledge of Language, Its Nature, Origin, and Use*. Westport: Praeger.

Chomsky, N. (1988a) *Language and Problems of Knowledge: The Managua Lectures*. Cambridge MA / London UK: MIT Press.

Chomsky, N. (1988b) 'Things no amount of learning can teach' in C. Otero (ed.) (1988) *Language and Politics*, 406-419. New York: Black Rose.

Chomsky, N. (1991a) ‘Linguistics and Adjacent Fields: A Personal View’ in A. Kasher (1991) *The Chomskyan Turn*, 3-25. Cambridge MA / Oxford UK: Blackwell.

Chomsky, N. (1991b) ‘Linguistics and Cognitive Science: Problems and Mysteries’ in A. Kasher (1991) *The Chomskyan Turn*, 26-53. Cambridge MA / Oxford UK: Blackwell.

Chomsky, N. (1993) *Language and Thought*. Rhode Island US / London UK: Moyer Bell.

Chomsky, N. (2000) *New Horizons in the Study of Language and Mind*. Cambridge: Cambridge University Press.

Chomsky, N. (2002) *Cartesian Linguistics* (second edition). Cybereditions.

Chomsky, N. (2003) ‘Replies’ in L. M. Antony and N. Hornstein (eds.) (2003) *Chomsky and His Critics,* 255-328. Oxford: Blackwell Publishing.

Collins, J. (2002) ‘On The Very Idea of a Science Forming Faculty.’ *Dialectica* 56: 125-151.

Collins, J. (2004) ‘Faculty Disputes.’ *Mind and Language* 19: 503-533.

Collins, J. (2007) ‘Meta-Scientific Eliminativism: A Reconsideration of Chomsky’s Review of Skinner’s *Verbal Behaviour*.’ *British Journal for the Philosophy of Science* 58: 625-658.

Collins, J. (2008) *Chomsky: A Guide for the Perplexed*. London UK / New York: Continuum.

Collins, J. (2010) ‘Naturalism in the Philosophy of Language; or Why There Is No Such Thing As Language’ in S. Sawyer (ed.) (2010) *New Waves in Philosophy of Language*, 41-59. Basingstoke: Palgrave Macmillan.

Cushing, J. (2003) *Philosophical Concepts in Physics: The Historical Relation Between Philosophy and Scientific Theories*. Cambridge & New York: Cambridge University Press.

Davidson, D. (1970/80) ‘Mental Events’ reprinted in D. Davidson (1980) *Essays on Actions and Events,* 207-225. Oxford UK / New York: Clarendon Press (Oxford University Press).

Davidson, D. (1973/80) ‘The Material Mind’ reprinted in D. Davison (1980) *Essays on Actions and Events*, 245-259. Oxford UK / New York: Clarendon Press (Oxford University Press).

Davidson, D. (1974/80) ‘Psychology as Philosophy’ reprinted in D. Davison (1980) *Essays on Actions and Events*, 229-239. Oxford UK / New York: Clarendon Press (Oxford University Press).

Davidson, D. (1984/86) ‘A Coherence Theory of Truth and Knowledge’ reprinted in E. Lepore (ed.) (1986) *Truth and Interpretation: Perspectives on the Philosophy of Donald Davidson*, 307-319. Oxford UK / New York: Basil Blackwell.

Davidson, D. (1995/2004) ‘The Problem of Objectivity’ in D. Davidson (2004) *Problems of Rationality*, 3-18. Oxford UK / New York: (Clarendon Press) Oxford University Press.

Demopoulos, W. and Friedman, M. (1985) ‘Critical Notice: Bertrand Russell’s *The Analysis of Matter*: Its Historical Context and Contemporary Interest.’ *Philosophy of Science* 52: 621-639.

Dennett, D. (1984) ‘Forward’ in R. G. Millikan (1984) *Language, Thought, and Other Biological Categories*, ix-x. London UK / Cambridge MA: MIT Press.

Dennett, D. (1991) ‘Real Patterns.’ *The Journal of Philosophy* 88: 27-51.

Einstein, A. (1916/97) ‘The Foundation of the General Theory of Relativity’ reprinted in A. Einstein (1997) *The Collected Papers of Albert Einstein: Volume 6* (eds. A. J. Kox, M. J. Klein and R. Schulmann, trans. A. Engel, consultant E. Schucking), 146-200. Princeton NJ: Princeton University Press.

Einstein, A. (1919/54/82) ‘What is the theory of relativity?’ reprinted in A. Einstein (1954/82) *Ideas and Opinions* (ed. C. Seelig, trans. S. Bargmann), 227-232. New York: Three Rivers Press.

Einstein, A. (1920) *Relativity: the Special and the General Theory*. New York: Three Rivers Press.

Einstein, A. (1921a/54/82) ‘Geometry and Experience’ reprinted in A. Einstein (1954/82), *Ideas and Opinions* (ed. C. Seelig, trans. S. Bargmann), 232-246. New York: Three Rivers Press.

Einstein, A. (1921b/34/54/82) ‘On The Theory of Relativity’ reprinted in A. Einstein (1954/82) *Ideas and Opinions* (ed. C. Seelig, trans. S. Bargmann), 246-249. New York: Three Rivers Press.

Einstein, A. (1927/54/82) ‘The Mechanics of Newton and Their Influence on the Development of Theoretical Physics’ reprinted in A. Einstein (1954/82)

Ideas and Opinions (ed. C. Seelig, trans. S. Bargmann), 253-261. New York: Three Rivers Press.

Feigl, H. (1958) ‘The “Mental” and the “Physical”’ in H. Feigl, M. Scriven and G. Maxwell (eds.) (1958) *Minnesota Studies in the Philosophy of Science Volume II: Concepts, Theories, and the Mind-Body Problem*, 370-497. Minneapolis: University of Minnesota Press.

Fodor, J. (1975) *The Language of Thought*. Cambridge MA: Harvard University Press.

Fodor, J. (1983) *The Modularity of Mind*. Cambridge MA / London UK: MIT Press.

Fodor, J. (2001) *The Mind Doesn’t Work That Way: The Scope and Limits of Computational Psychology*. Cambridge MA / London UK: MIT Press.

French, S. (2009) ‘Metaphysical underdetermination: why worry?’ *Synthese (“Online First” publication)* DOI: 10.1007/s11229-009-9598-5.

French, S. and Ladyman, J. (2003a) ‘Remodelling Structural Realism: Quantum Physics and the Metaphysics of Structure.’ *Synthese* 136: 31-56.

French, S. and Ladyman, J. (2003b) ‘The Dissolution of Objects: Between Platonism and Phenomenalism.’ *Synthese* 136: 73-77.

Friedman, M. (1977) ‘Simultaneity in Newtonian Mechanics and Special Relativity’ in J. Earman, C. N. Glymour, J. J. Stachel (eds.) (1977) *Minnesota Studies in the Philosophy of Science, Volume VIII: Foundations of Space-Time Theories*, 403-432. Minneapolis: University of Minnesota Press.

Friedman, M. (1992) *Kant and the Exact Sciences*. Cambridge MA / London UK: Harvard University Press.

Friedman, M. (1999) *Reconsidering Logical Positivism*. Cambridge UK / New York: Cambridge University Press.

Friedman, M. (2000) *A Parting of the Ways: Carnap, Cassirer, and Heidegger*. Chicago, Illinois: Open Court.

Friedman, M. (2001) *Dynamics of Reason*. California: CSLI Publications.

Friedman, M. (2003) ‘Transcendental Philosophy and Mathematical Physics.’ *Studies in History and Philosophy of Science* 34: 29-43.

Friedman, M. (2006) ‘Philosophy of Natural Science’ in P. Guyer (ed.) (2006) *The Cambridge Companion to Kant and Modern Philosophy*, 303-341. Cambridge UK / New York: Cambridge University Press.

Giaquinto, M. (2002) *The Search for Certainty*. Oxford UK / New York: Clarendon Press (Oxford University Press).

Gödel, K. (1934/86) ‘On undecidable propositions of formal mathematical systems’ reprinted in K. Gödel (and S. Fereman *et al*, eds.) (1986) *Kurt Gödel: Collected Works Volume I (Publications 1929-1936)*, 346-372. Oxford UK / New York: Oxford University Press.

Gödel, K. (1947/90) ‘What is Cantor’s continuum problem?’ reprinted in K. Gödel (and S. Fereman *et al*, eds.) (1990) *Kurt Gödel: Collected Works Volume II (Publications 1938-1974)*, 176-187. Oxford UK / New York: Oxford University Press.

Gödel, K. (1964/90) ‘What is Cantor’s continuum problem?’ reprinted in K. Gödel (and S. Fereman *et al*, eds.) (1990) *Kurt Gödel: Collected Works Volume II (Publications 1938-1974)*, 254-270. Oxford UK / New York: Oxford University Press.

Guyer, P. (1987) *Kant and the claims of knowledge*. Cambridge: Cambridge University Press.

Guyer, P. (2006) *Kant.* Oxford UK / New York: Routledge.

Hanna, R. (2001) *Kant and the Foundations of Analytic Philosophy*. Oxford / New York: Oxford University Press.

Hanna, R. (2006) *Kant, Science, and Human Nature*. Oxford UK / New York: Clarendon Press (Oxford University Press).

Holton, G. (1960/63) ‘On the Origins of the Special Theory of Relativity’ reprinted in G. Holton (1963) *Special Relativity Theory: Selected Reprints*, 10-19. New York: American Institute of Physics.

Holton, G. (1965) ‘Introduction to Concepts and Theories in Physical Science’ reprinted (as ‘Chapters 10-15’) in A. B. Arons, (with Holton, G.) (1965) *Development of Concepts in Physics*, 248-330. London UK / Reading MA: Addison-Wesley Publishing.

Holton, G. (1973/88) *Thematic Origins of Scientific Thought: Kepler to Einstein* (revised edition). Cambridge MA / London UK: Harvard University Press.

Hopkins, J. (1973) ‘Visual Geometry.’ *The Philosophical Review* 82: 3-34.

Kant, I. (1781/87/1998/2003) *Critique of Pure Reason (The Cambridge Edition of the Works of Immanuel Kant)* (eds. and trans., P. Guyer and A. W. Wood). Cambridge UK / New York: Cambridge University Press.

Kant, I. (1783/1977/2001) *Prolegomena to Any Future Metaphysics* (second edition, trans. and introduction by J. W. Ellington). Indianapolis: Hackett Publishing.

Kant, I. (1786/2002) *Metaphysical Foundations of Natural Science* (trans. M. Friedman) in H. Allison and P. Heath (eds.) (2002) *Theoretical Philosophy after 1781* (trans. G. Hatfield, M. Friedman, H. Allison and P. Heath), 171-270. Cambridge UK / New York: Cambridge University Press.

Kant, I. (1788/1996/2004) *Critique of Practical Reason* in M. G. Gregor (ed. and trans.) (1996/2004) *The Cambridge Edition of the Works of Immanuel Kant: Practical Philosophy* (introduction by A. Wood), 133-271. Cambridge UK / New York: Cambridge University Press.

Kant, I. (1790/2000) *Critique of the Power of Judgement (The Cambridge Edition of the Works of Immanuel Kant)* (ed., P. Guyer, trans., P. Guyer and E. Matthews). Cambridge UK / New York: Cambridge University Press.

Kant, I. (1936/38/93) *Opus postumum* (ed. E. Förster, trans. E. Förster and M. Rosen). Cambridge: Cambridge University Press.

Kemp Smith, N. (1918/23/2003) *A Commentary to Kant's* '*Critique of Pure Reason*'. New York: Humanities Press.

Ketland, J. (2004) 'Empirical Adequacy and Ramsification.' *British Journal for the Philosophy of Science* 55: 287-300.

Kim, J. (1998) *Mind in a Physical World*. Cambridge MA: MIT Press.

Kuhn, T. S. (1962/96) *The Structure of Scientific Revolutions* (third edition). London UK / Chicago: Chicago University Press.

Ladyman, J. (1998) 'What is Structural Realism?' *Studies in History and Philosophy of Science* 29: 409-424.

Ladyman, J. (2000) 'What's Really Wrong with Constructive Empiricism? Van Fraassen and the Metaphysics of Modality.' *British Journal for the Philosophy Science* 51: 837-856.

Ladyman, J. (2004) 'Constructive Empiricism and Modal Metaphysics: A Reply to Monton and van Fraassen.' *British Journal for the Philosophy of Science* 55: 755-765.

Ladyman, J. (2007) 'On the Identity and Diversity of Objects in a Structure.' *Proceedings of the Aristotelian Society Supplementary Volume LXXXI* 32-43.

Ladyman, J. (2008) 'Structural Realism and the Relationship between the Special Sciences and Physics.' *Philosophy of Science* 75: 744-755.

Ladyman, J. and Ross, D. (with Spurrett, D. and Collier, J.) (2007) *Every Thing Must Go: Metaphysics Naturalized*. Oxford: Oxford University Press.

Langston, R. F. *et al*. (2010) 'Development of the Spatial Representation System in the Rat.' *Science* 328: 1576-80.

Laudan, L. (1981) 'A Confutation of Convergent Realism' *Philosophy of Science*. 48: 19-49.

Lewis, D. (1966/83) 'An Argument for the Identity Theory' reprinted in D. Lewis (1983) *Philosophical Papers: Volume I*, 99-107. Oxford UK / New York: Oxford University Press.

Lewis, D. (1986) *Philosophical Papers: Volume II*. Oxford UK / New York: Oxford University Press.

Maxwell, G. (1962) 'The Ontological Status of Theoretical Entities' in H. Feigl and G. Maxwell (eds.) (1962) *Minnesota Studies in the Philosophy of Science Volume III: Scientific Explanation, Space, and Time*, 3-27. Minneapolis: University of Minnesota Press.

Maxwell, G. (1970) 'Structural Realism and the Meaning of Theoretical Terms' in M. Radner and S. Winokur (1970) *Minnesota Studies in the Philosophy of Science Volume IV: Analyses of Theories and Methods of Physics and Psychology*, 181-192. Minneapolis: University of Minnesota Press.

McGinn, C. (1991) *The Problem of Consciousness: Essays Towards a Resolution*. Oxford UK / Cambridge MA: Basil Blackwell.

McGinn, C. (1993) *Problems in Philosophy: The Limits of Inquiry*. Oxford UK / Cambridge MA: Blackwell.

McGinn, C. (2004) *Consciousness and its Objects*. Oxford UK / New York: Clarendon Press (Oxford University Press).

Melia, J. and Saatsi, J. (2006) 'Ramseyfication and Theoretical Content.' *British Journal for the Philosophy of Science* 57: 561-585.

Monton, B. and van Fraassen, B. (2003) 'Constructive Empiricism and Modal Nominalism.' *British Journal for the Philosophy of Science* 54: 405-422.

Moore, A. (1990/2001) *The Infinite* (second edition). Oxon UK / New York: Routledge.

Nagel, T. (1974) 'What Is It Like To Be A Bat?' *The Philosophical Review* 83: 435-450.

Nagel, T. (1986/89) *The View From Nowhere*. Oxford UK / New York: Oxford University Press.

Newman, M. H. A. (1928) ‘Mr. Russell’s “Causal Theory of Perception” *Mind*. 37: 137-148.

Norton, J. (2007) ‘Causation as Folk Science’ in H. Price and R. Corry (eds.) (2007) *Causation, Physics and the Constitution of Reality*, 11-44. Oxford: Oxford University Press.

Oppenheim, P. and Putnam, H. (1958) ‘Unity of Science as a Working Hypothesis’ in H. Feigl, M. Scriven and G. Maxwell (eds.) (1958) *Minnesota Studies in the Philosophy of Science Volume II: Concepts, Theories, and the Mind-Body Problem*, 3-36. Minneapolis: University of Minnesota Press.

Palmer, L. and Lynch, G. (2010) ‘A Kantian View of Space.’ *Science* 328: 1487-8.

Papineau, D. (1993) *Philosophical Naturalism*. Oxford UK / Cambridge MA: Blackwell.

Parsons, C. (1992) ‘The Transcendental Aesthetic’ in P. Guyer (ed.) (1992) *The Cambridge Companion to Kant*, 62-100. Cambridge UK / New York: Cambridge University Press.

Place, U. T. (1956) ‘Is Consciousness a Brain Process?’ *British Journal of Psychology*. 47: 44-50.

Poincaré, H. (1902/13/46/82) *Science and Hypothesis* in H. Poincaré (1913/46/82) *The Foundations of Science* (trans. G. Halsted, ed. L. Pearce Williams), 1-197. Washington D.C.: University Press of America.

Poincaré, H. (1906/13/46/82) *The Value of Science* in H. Poincaré (1913/46/82) *The Foundations of Science* (trans. G. Halsted, ed. L. Pearce Williams), 199-355. Washington D.C.: University Press of America.

Poland, J. (2003) ‘Chomsky’s Challenge to Physicalism’ in L. M. Antony and N. Hornstein (eds.) (2003) *Chomsky and His Critics*, 29-48. Oxford: Blackwell Publishing.

Priest (2002) *Beyond the Limits of Thought*. Oxford UK / New York: Clarendon Press (Oxford University Press).

Psillos, S (1996) ‘On Van Fraassen’s Critique of Abductive Reasoning.’ *The Philosophical Quarterly* 46: 31-47.

Psillos, S. (2001) 'Is Structural Realism Possible?' *Philosophy of Science* 68 (Supplement: Proceedings of the Biennial Meeting of the Philosophy of Science Association): S13-S24.

Psillos, S. (2006) '*The* Structure, the *Whole* Structure, and Nothing *but* the Structure?' *Philosophy of Science* 73: 560-570.

Putnam, H. (1975) *Mathematics, Matter and Method*. Cambridge: Cambridge University Press.

Putnam, H. (1978/2010) *Meaning and the Moral Sciences*. Oxon UK / New York: Routledge.

Putnam, H. (1987) *The Many Faces of Realism*. LaSalle, Illinois: Open Court.

Pylyshyn, Z. (1984) *Computation and Cognition*. Cambridge MA / London UK: MIT Press.

Quine, W. V. O. (1951/53/64) 'Two Dogmas of empiricism' reprinted in W. V. O. Quine (1953/64) *From a Logical Point of View* (second edition), 20-46. Cambridge MA: Harvard University Press.

Quine, W. V. O. (1960) *Word and Object*. Cambridge MA: MIT Press.

Quine, W. V. O. (1969) 'Epistemology Naturalised' in W. V. O. Quine (1969) *Ontological Relativity and Other Essays*, 69-90. New York & London: Columbia University Press.

Quine, W. V. O. (1990) *Pursuit of Truth*. Cambridge MA / London UK: Harvard University Press.

Quine, W. V. O. (1992) 'Structure and Nature.' *The Journal of Philosophy* 89: 5-9.

Reichenbach, H. (1965) *The Theory of Relativity and A Priori Knowledge* (trans. & ed. M. Reichenbach). LA / London UK: University of California Press.

Rorty, R. (1986) 'Pragmatism, Davidson and Truth' in E. Lepore (ed.) (1986) *Truth and Interpretation: Perspectives on the Philosophy of Donald Davidson*, 332-355. Oxford UK / New York: Basil Blackwell.

Russell (1927/54) *The Analysis of Matter* (introduction by L. E. Denonn). London: George Allen and Unwin.

Ryckman, T. (2005) *The Reign of Relativity: Philosophy in Physics 1915-1925*. Oxford UK / New York: Oxford University press.

Ryle, G. (1949/63) *The Concept of Mind*. Middlesex: Penguin Books.

Schlick, M. (1915/79) 'The Philosophical Significance of the Principle of Relativity' in H. L. Mulder and B. F. B. Van de Velde-Schlick (eds.) (1979) *Moritz*

Schlick: Philosophical Papers Volume I (1909—1922) (trans. P. Heath), 153-189. Dordrecht / Boston / London: D. Reidel.

Schlick, M. (1922a/79) 'Critical or Empiricist Interpretation of Modern Physics?' in H. L. Mulder and B. F. B. Van de Velde-Schlick (eds.) (1979) *Moritz Schlick: Philosophical Papers Volume I (1909—1922)* (trans. P. Heath), 322-334. Dordrecht / Boston / London: D. Reidel.

Schlick, M. (1922b/79) 'The Theory of Relativity in Philosophy' in H. L. Mulder and B. F. B. Van de Velde-Schlick (eds.) (1979) *Moritz Schlick: Philosophical Papers Volume I (1909—1922)* (trans. P. Heath), 343-353. Dordrecht / Boston / London: D. Reidel.

Scholl, B. J. (2005) 'Innateness and (Bayesian) Visual Perception' in P. Carruthers, S. Laurence and S. Stich (2005) *The Innate Mind: Structure and Contents*, 34-52. Oxford UK / New York: Oxford University Press.

Schopenhauer, A. (1859/1966/69) *The World as Will and Representation: Volume I* (trans. E. F. Payne). New York: Dover.

Shusterman, A. and Spelke, E. (2005) 'Language and the Development of Spatial Reasoning' in P. Carruthers, S. Laurence and S. Stich (2005) *The Innate Mind: Structure and Contents*, 89-106. Oxford UK / New York: Oxford University Press.

Smart, J. J. C. (1959) 'Sensations and Brain Processes.' *The Philosophical Review* 68: 141-156.

Smith. P. (2007) *An Introduction to Gödel's Theorems*. Cambridge UK / New York: Cambridge University Press.

Sperber, D. (2005) 'Modularity and Relevance: How Can a Massively Modular Mind be Flexible and Context-Sensitive?' in P. Carruthers, S. Laurence and S. Stich (2005) *The Innate Mind: Structure and Contents*, 53-68. Oxford UK / New York: Oxford University Press.

Steiner, M. (2005) 'Mathematics—Application and Applicability' in Shapiro, S. (ed.) (2005) *The Oxford Handbook of Philosophy of Mathematics and Logic*, 626-650. Oxford UK / New York: Oxford University Press.

Strawson, P. F. (1966) *The Bounds of Sense: An Essay on Kant's Critique of Pure Reason*. London: Methuen.

Strawson, P. F. (1985) *Skepticism and Naturalism: Some Varieties (The Woodbridge Lectures 1983)*. New York: Columbia University Press.

Torretti, R. (1978) *Philosophy of Geometry from Riemann to Poincaré*. Dordrecht / Boston / London: D. Reidel.

Torretti, R. (1999) *The Philosophy of Physics*. Cambridge UK / New York: Cambridge University Press.

Tye, M. (1992) 'Naturalism and the Mental.' *Mind* 101: 421-441.

Van Cleve, J. (1999) *Problems from Kant*. Oxford UK / New York: Oxford University Press.

Van Fraassen, B. (1980) *The Scientific Image*. Oxford UK / New York: Clarendon Press (Oxford University Press).

Van Fraassen, B. (2003) 'Constructive Empiricism and Modal Nominalism.' *British Journal for the Philosophy of Science* 54: 405-422.

Van Fraassen, B. (2006a) 'Structure: Its Shadow and Substance.' *British Journal for the Philosophy of Science* 57: 275-307.

Van Fraassen, B. (2006b) 'Representation: The Problem for Structural Realism.' *Philosophy of Science* 73: 536-547.

Van Fraassen, B. (2007) 'Structuralism(s) about Science: Some Common Problems.' *Proceedings of the Aristotelian Society Supplementary Volume LXXXI* 45-61.

Weinberg, S. (1993) *Dreams of a Final Theory*. London UK: Vintage.

Weyl, H. (1932/2009) 'The Open World: Three Lectures on the Metaphysical Implications of Science' reprinted in H. Weyl (2009) *Mind and Nature: Selected Writings on Philosophy, Mathematics, and Physics* (ed. P. Pesic, introduction by P. Pesic), 34-82. Oxford UK / Princeton: Princeton University Press.

Weyl (1949) *Philosophy of Mathematics and Natural Science* (trans. O. Helmer). Princeton: Princeton University Press.

Weyl (1922/52) *Space Time Matter* (trans. H. Brose). New York: Dover Publications.

Wigner, E. P. (1960/67/79) 'The Unreasonable Effectiveness of Mathematics in the Natural Sciences' reprinted in E. P. Wigner (1967/79) *Symmetries and Reflections: Scientific Essays*, 222-237. Woodbridge CT: Oxbow Press.

Wills, T. J. *et al*. (2010) 'Development of the Hippocampal Cognitive Map in Preweanling Rats.' *Science* 328: 1573-6.

Worrall, J. (1989) 'Structural Realism: The Best of Both Worlds?' *Dialectica* 43: 99-124.

Zee, A. (1986/99/2007) *Fearful Symmetry: The Search for Beauty in Modern Physics* (forward by R. Penrose). Princeton: Princeton University Press.