Kant's Influence on the Development of Biology:

A Critical Consideration from Historical and Contemporary Perspectives

Andrew Jones

School of English, Communication and Philosophy

Cardiff University

Thesis Submitted in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

September 2018

DECLARATION

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is being submitted concurrently in candidature for any degree or other award.

Signed ……(candidate) Date ……..……

STATEMENT 1

This thesis is being submitted in partial fulfilment of the requirements for the degree of PhD

Signed ……(candidate) Date ……

STATEMENT 2

This thesis is the result of my own independent work/investigation, except where otherwise stated, and the thesis has not been edited by a third party beyond what is permitted by Cardiff University's Policy on the Use of Third Party Editors by Research Degree Students. Other sources are acknowledged by explicit references. The views expressed are my own.

Signed ……(candidate) Date ……

STATEMENT 3

I hereby give consent for my thesis, if accepted, to be available online in the University's Open Access repository and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed ……(candidate) Date ……

STATEMENT 4: PREVIOUSLY APPROVED BAR ON ACCESS

I hereby give consent for my thesis, if accepted, to be available online in the University's Open Access repository and for inter-library loans **after expiry of a bar on access previously approved by the Academic Standards & Quality Committee.**

Signed ……(candidate) Date ……

Abstract

Previous discussions of Kant's influence on German biology have resulted in contradictory accounts. Zammito argues both that Kant could not have influenced German biology because his account is fundamentally incompatible with the presuppositions of biological naturalism, and biology only emerged because biologists misunderstood Kant's philosophy. I argue that his account exposes an important difficulty when considering Kant's influence on the development of biology, since it correctly identifies a fundamental incompatibility between biological naturalism and Kant. However, this does not demonstrate that Kant could not have been influential on the development of biology. Instead, I propose a broader conception of influence that includes both intentional and non-intentional forms of misunderstanding.

I examine Kant's influence on the development of biology in the British Isles. Both in the history of science and contemporary research, the literature tends to focus on Kant's 'Critique of Teleological Judgment' as this is where Kant discusses how biological entities require us to judge them as if they possessed the properties of self-organization, growth and reproduction. I argue that Kant's influence on biology in the British Isles originates from his account of scientific methodology in his earlier work, the *Critique of Pure Reason*. Kant's account was influential on William Whewell. Kant argued that the unity of science was merely a presupposition for scientific enquiry, whereas Whewell argued this unity was an inherent property of the world that science was discovering. I argue that Whewell intentionally misinterpreted aspects of Kant's philosophy to develop a more naturalistic theory of science. Whewell was influential on the development of Darwin's scientific methodology in the *Origin* as he argues for the correctness of his theory on the basis that it displays consilience. Whewell's account of science was not only influential for the development of biology but also for more recent accounts of scientific methodology and reductivist accounts of science.

I argue that this dual philosophical-historical approach provides the basis for a richer, more adequate understanding of how Kant's philosophy has continued to exert a strong though often unrecognised influence on developments in biological theory such as immunology and contemporary accounts of biological autonomy. All the same that influence is highly problematic because of the original incompatibility between transcendental idealism and biological naturalism. Understanding how aspects of Kant's philosophy are intertwined with both the development of biology and contemporary philosophy of biology allows us to assess the conjoint costs and benefits of the synthesis between Kant's philosophy and philosophy of biology.

Acknowledgements

There are many people that deserve thanks for their help during the development of this project over the last four years. First, I thank the South West and Wales Doctoral Training Partnership for funding this research. In addition, I thank them for funding a 5-month working-placement at Citizens Advice North Somerset.

I thank my supervisor Professor Christopher Norris (Cardiff University) for his patience, guidance, and continuous support throughout this thesis. I also thank my second supervisor Professor John Dupré (Exeter) for his helpful discussions on issues relating to Kant and philosophy of biology. I thank the members of the Kant reading group at Cardiff University: Professor Howard Williams, Professor Andrew Vincent, Professor John Saunders, and Professor Hugh Compston. Our discussions about various aspects of Kant's philosophy over the past three years have been both academically and personally enlightening. I also thank Professor Samir Okasha, Dr Andrew Pyle, and Dr Jonathan Grose for allowing me to attend lectures and seminars at the University of Bristol (2015-2016) for modules on the Philosophy of biology, History of Science, and Scientific Epistemology and Methodology.

Finally, I thank my parents for their continuous encouragement and support.

***

An extended version of Chapter Five (section three) is forthcoming as 'The philosophical commitments of the self-metaphor in immunology'. In *Parasites: Exploitation and Interference in French Culture* Edited Phillips, M. and Weber, T. New York: Peter Lang

Table of Contents

Abbreviations

Kant, I.

Citations from Kant's texts refer to volume and page numbers in the Akademie edition, except for references to the *Critique of Pure Reason*, which is cited by page numbers in the original first (A) and second (B) editions.

C	(2000) *Correspondence*. Translated/edited by Zweig, A. Cambridge: Cambridge University Press
CJ	(2000) *Critique of the Power of Judgment.* Translated/edited by Guyer, P. and Matthews, E. Cambridge: Cambridge University Press
CPR	(1998) *Critique of Pure Reason*. Translated/edited by Guyer, P. and Wood, A. Cambridge: Cambridge University Press
CPrR	(1993) *Critique of Practical Reason*. Translated by Beck, L, W. New York: Macmillan
G	(1998) *Groundwork of the Metaphysics of Morals.* Translated/edited by Gregor, M. Introduction by Korsgaard, C. Cambridge: Cambridge University Press
HR	(1991) Review of Herder's Ideas on the Philosophy of the History of Mankind. Translated by Nisbet, H. in Kant: Political Writings. Edited by Reiss, H. Cambridge: Cambridge University Press. pp.201-220
JL	(1974) *Logic*. Translated/edited by Hartman, R. and Schwarz, W. New York: Dover Publications
MF	(2004) *Metaphysical Foundations of Natural Science*. Translated/edited by Friedman, M. Cambridge: Cambridge University Press
MM	(1996) *The Metaphysics of Morals.* Translated by Gregor. M. In *Practical Philosophy*. Translated/edited Gregor, M. Introduction by Wood, A. Cambridge: Cambridge University Press, pp.353 -604

OT (1996) *What Does it Mean to Orient Oneself in Thinking?* Translated by Wood, A. in *Religion and Rational Theology*. Edited by Wood, A. and Giovanni, G. Cambridge: Cambridge University Press, pp.1-18

P (2004) *Prolegomena to Any Future Metaphysics*. Translated/edited by Hatfield, G. Cambridge: Cambridge University Press

PM (2002) What real progress has metaphysics made in Germany since the time of Leibniz and Wolff? Translated by Heath, P. in *Theoretical Philosophy after 1781*, translated/edited by Allison, H. Friedman, M. Hatfield, G. and Heath, P. Cambridge: Cambridge University Press, pp.337-424

Hume, D.

E (1975) *Enquiries Concerning Human Understanding and Concerning the Principles of Morals.* Edited by Selby-Bigge, L. and Nidditch, P. 3rd Edition. Oxford: Clarendon Press

T (1978) A *Treatise On Human Nature*. Edited by Selby-Bigge, L. and Nidditch, P. 2nd Edition. Oxford: Clarendon Press

Whewell, W.

NOR (1858) *Novum Organon Renovatum*. 3rd Edition. London: John W. Parker and Son

PIS (1847) *The Philosophy of the Inductive Sciences*. (2 vols). London: John W. Parker and Son

POD (1860) *On the Philosophy of Discovery*. London: John W. Parker and Son

HIS (1858) *History of Scientific Ideas*. London: John W. Parker and Son

Introduction

Kant's critical philosophy has a tenuous relationship with the philosophy of biology. Kant himself raised problems for the possibility of biology as a proper natural science. A proper science must be grounded on principles that are apodictically necessary in contrast to improper sciences that are derived from mere laws of experience (MF 4:468). Even this statement should be approached with caution as Kant's philosophy preceded, and was in part responsible for, the emergence of the biological sciences. The term biology first appeared ten years after the publication of the Third *Critique*.[1]

The conditions that Kant outlined for the fulfilment of a proper science do not generally correspond to the conditions of science as understood in contemporary philosophy of biology. Transcendental idealism establishes the conditions for distinguishing between knowledge of appearances of objects from knowledge of objects as they are in themselves. In contrast, philosophers of science generally do not argue for a difference in kind between the objects of experience and objects in themselves.

It might seem that the differences between the foundations of Kant's critical philosophy and philosophy of science are insurmountable so that any collaboration between these two disciplines could not be fruitful. For instance, Zammito has been critical of recent appeals to Kant's philosophy to help resolve issues in contemporary philosophy of biology (Zammito, 2006). However, research into the relationship between Kant and biology has been growing over the last 30 years. This relationship has been considered from historical and philosophical perspectives. In addition, some philosophers of biology have appealed to aspects of Kant's discussion of teleological judgment as helping to resolve issues in contemporary philosophy of biology. These different approaches to understanding Kant's influence on the development of biology have significantly overlapped at times, yet there have not been many accounts that attempt to understand Kant's relationship with biology from both historical and philosophical perspectives.

This thesis is an examination of both the historical and philosophical implications of the influence of Kant's critical philosophy on the development of biology in the British

[1] The term first appeared in a footnote in a German medical journal in 1800 and then re-appeared independently in 1802 in the works of the German naturalist, Treviranus, and the French zoologist, Lamarck (Coleman, 1977, p.1)

Isles in the 19th Century. This dual approach makes it possible to consider the extent to which Kant's influence on biology has been compatible with the original deployment of his theory. To appeal to a Kantian distinction, we aim to distinguish the warrant (*quid juris*) from the fact (*quid facti*) of the matter. In this context, the former concerns the entitlement or justification for the use of a concept, while the latter concerns the fact that concepts are actually used (CPR A84/B116). When philosophers of science have engaged with Kant, both historically and within contemporary philosophy of biology, these subsequent deployments of Kant's philosophy have rarely been consistent with their original development in the context of Kant's critical philosophy. Hence, it is important to distinguish the fact that these philosophers of biology have appealed to Kant's philosophy from their warrant for doing so.

Hacking has also investigated how the relation between history and philosophy could potentially be fruitful. However, he warns against the tendency to approach philosophy with romantic dispositions. According to Hacking,

> When history and philosophy intersect, their students must put aside the romantic cravings that so often occlude the vision of philosophers, whether they lust after a moment of original purity or long for an *a priori* framework. Some mingling of history and philosophy can, however, exhibit how possibilities came into being, creating, as they did so, new conundrums, confusions, paradoxes (Hacking, 2002, p.7)

Hacking correctly identifies that the overlap between history and philosophy can create opportunities to expose confusions and paradoxes that might have otherwise remained invisible. However, his argument that it is necessary to cast aside philosophical dispositions is problematic. It would not be possible to assess whether these appeals to Kantian principles were warranted without considering them in the context of the original formulation of transcendental idealism. This does not entail that Kant offered the correct account of these matters and that philosophies which deviate from the original use of these principles are automatically incorrect. The central issue is whether the principles which have been developed by appealing to Kant's philosophy can be sufficiently justified.

This is indicative of a deeper tension between transcendental idealism and naturalism that has been the focus of hostility toward the relevance of Kant's philosophy for contemporary philosophy of biology. According to Zammito '[n]aturalist philosophers of biology today need not succumb to the scruples (whether 'absolute' or

'transcendental') that haunted eighteenth-century philosophers' (Zammito, 2006, p.766). Zammito's concern regarding the incompatibility between naturalism and transcendentalism exposes an important difficulty that arises when attempting to understand Kant's influence on the development of biology. This tension is an important factor to consider when examining the influence of Kant's critical philosophy on biology, but this cannot overlook the crucial points where Kant's critical philosophy has both been significant for the development of biology and is still appealed to by contemporary philosophers of biology; hence his influence cannot be denied on account of this difficult relationship between transcendental idealism and naturalism.

Previous accounts of Kant's influence on biology have focused on the development of 19th century German biology. For instance, Lenoir argued that Kant's philosophy constituted the hardcore element of the teleomechanist research program. Zammito and Richards have criticised Lenoir for not sufficiently recognising the incompatibility between Kant's transcendental idealism and its subsequent naturalistic deployment within biology. By distinguishing the warrant for an influence from the fact that an influence has occurred, it is possible to establish a middle ground between these two positions. I argue that the criticisms against Lenoir do not demonstrate that Kant did not influence biology, but rather that Kant's influence could not be sufficiently justified in accordance with biological naturalism. The denial that Kant could have influenced the development of biology because this influence is unwarranted places an unrealistic demand on the context of discovery of scientific theories. There are many instances where scientific theories develop in accordance with metaphors that stimulate research. According to Lewontin many of the foundations of science are metaphorical:

> It is not possible to do the work of science without using language that is filled with metaphors. Virtually the entire body of modern science is an attempt to explain phenomena that cannot be experienced directly by human beings […]. Physicists speak of "waves" and "particles" even though there is no medium in which the "waves" move and no solidity to those "particles". Biologists speak of genes as "blueprints" and DNA as "information". (Lewontin, 2000, p.3)

This indicates that many well-received aspects of science are inseparable from the contextual metaphors that have been instrumental for the development of scientific theories. This brings into question the assumption that science is grounded solely on naturalistic principles. For Lewontin, the cost of the use of such metaphors in science is that it must remain vigilant against confusing metaphors with the real things of interest.

If we bestow on these metaphors a greater degree of reality than is warranted, we cease to see the world *as if* it is a certain a way and instead take it to *be* that way (Lewontin, 2000, p.4). Lewontin identifies this as a central issue for contemporary philosophy of science; this separation of the metaphorical and real objects of science resonates with the intention of Kant's critical philosophy. Kant argued that this required a reorientation of enquiry away from the view that objects independent of experience—or objects in themselves—have identical features to the objects of experience; instead we must focus on the human faculties that make different kinds of experience possible. He considered our claims to knowledge in a fundamentally juridical manner. By distinguishing the appropriate domains for knowledge he aimed to provide the ground for reason to 'secure its rightful claims while dismissing all its groundless pretensions, and this not by mere decrees but according to its own eternal and unchangeable laws; and this court is none other than the **critique of pure reason** itself' (CPR Axi-Axii).

The faculties that Kant demarcated were sensibility, understanding, and reason. Kant's critical philosophy, understood as an architectonic system, is an examination of how these faculties relate to one another to produce different forms of cognitive content that have different warranted domains of application. Crucially, we must first understand the appropriate boundaries of knowledge, what Strawson termed 'the bounds of sense', before we can engage in a scientific understanding of the world. In this sense, the context of Kant's discussion of biology must be understood in the broader context of his critical philosophy. Kant's account of teleological judgment (or biology) plays a crucial role in the architectonic structure of our faculties as finite rational beings. In this sense Kant's account of the organism is inseparable from the context of transcendental idealism. Kant aims to develop a systematic account of the faculties of finite rational beings that establishes the necessary conditions for epistemology, metaphysics, morality, politics, teleological judgment, and more. Central to all these discussions is the emphasis on the subject as the foundation for establishing transcendental arguments that demonstrate the synthetic *a priori* principles to reveal the necessary conditions for the possibility of knowledge in these diverse areas. In this sense, many features of transcendental idealism are 'exactly backwards' or 'contrary to plain sense' according to contemporary conventional wisdom (Engstrom, 2017, p.28).

The issue at the core of this thesis—Kant's historical and philosophical relationship to biology—is in a sense inherited because both Kant scholars and

philosophers of biology are appealing to Kant's critical philosophy for potential resolutions to issues in contemporary philosophy of biology. This demands a broader examination of both the philosophical warrant to deploy concepts and principles that were originally embedded in Kant's critical philosophy and the historical context that has led philosophers and philosophers of biology to engage with these principles.

The first chapter examines Lenoir's argument that Kant's philosophy of biology formed the hardcore element of the research program of teleomechanism. Lenoir's account has been criticised because it does not consider the incompatibility between Kant's account of organisms as the product of regulative judgment and the biological understanding of organisms as entities that exist independent of judgment. I argue that this is a result of Lenoir's commitment to a Lakatosian account of influence which entails that foundational principles or the 'hardcore elements' of any research program are protected from critical enquiry. Instead, scientific experimentation is directed toward auxiliary hypotheses, that if proved wrong, do not bring the scientific theory into question. Lakatos' conception of research programs developed from Kuhn's account of scientific paradigms which suggested that theories blindly accumulated anomalies without any method to judge their potential significance for the theory. I argue both Kuhn's and Lakatos' accounts presuppose that an influence must be compatible with its source. I contrast their accounts with alternative conceptions of influence which avoid this presupposition such as those of Feyerabend and Bloom which explain how influence can arise from misunderstanding or misprision. This allows us to avoid the implicit requirement that Lenoir imposes on claims concerning Kant's influence on 19th century German biology, specifically that influence presupposes compatibility. In contrast, by considering Kant's influence on the development of biology without demanding that Kant's critical philosophy is compatible with biology we avoid Zammito's criticism of the Lenoir thesis. Zammito argues that because biologists misunderstood Kant, his influence on philosophy of biology must have been minimal. This lays the foundation for my examination of Kant's influence on the development of biology in the British Isles in the 19th century.

The second chapter considers Hume's influence on the development of Kant's critical philosophy. Examining Kant's philosophy as developing from Hume shows how transcendental idealism can be understood as responding to the shortcomings of empirical scepticism. Kant's interpretation of Hume is primarily derived from Hume's *Enquiry*, as

it is generally accepted that the *Treatise* was not available to Kant at the time he developed his critical philosophy. He perceived a parity between Hume's philosophy and his critical philosophy because of their shared concern with the possibility of deriving certainty from appearances. Importantly, Kant misidentifies this parity with Hume's matters of fact as Kant misunderstood Hume's distinction between matters of facts and relations of ideas since he regarded it as a logical, rather than a psychological, distinction. For Hume, relations of ideas were not true independent of experience, rather they required a single experience to demonstrate their certainty. This exposes a strong similarity between Hume's relations of ideas and Kant's account of synthetic *a priori* truths which Kant overlooked. This interpretation of Kant as developing from the shortcomings of Hume's sceptical empiricism reveals how the fundamental tenets of transcendental idealism are responding to Hume. Kant praised Hume for demonstrating the impossibility of establishing a rational ground for knowledge of necessary causal connections relating to objects in themselves. In this sense, he regarded transcendental idealism as developing from the problems identified by Hume's naturalism. I consider Hume's influence on Kant in relation to Allison's two-aspect and Guyer's two-world interpretations and examine how the relation between Kant's accounts of theoretical and practical philosophy can be understood as an extension of Hume's influence on Kant. Finally, Kant's account is contrasted with accounts of the metaphysical status of laws in contemporary philosophy of science. I focus on Bhaskar's transcendental (or critical) realism and Cartwright's nomological pluralism. The fundamental difference between these accounts is that Bhaskar argues that we must presuppose the existence of intransitive necessary laws for the possibility of science, whereas there is little empirical justification for the existence of such laws according to Cartwright. Both present their positions in the form of transcendental arguments, yet they arrive at incompatible conclusions. From the perspective of transcendental idealism, these deployments of transcendental arguments cannot be warranted as they are not aiming to identify necessary conditions for possible experience, but necessary conditions at the metaphysical level.

The third chapter considers how Kant influenced the development of biology on the British Isles in the 19th century. Whewell's account of the active powers of the mind was derived from Kant. The consequences of Kant's influence are doubled-edged, Kant helped Whewell appreciate the active powers of the mind in its engagement with nature; however, these active powers were inseparable from transcendental idealism in the

context of Kant's critical philosophy. Whewell regarded knowledge as the product of a fundamental antithesis between thoughts and things. He argued that the ability of science to explain nature in accordance with theories with greater scope that tended toward simplicity (or 'consilience') was sufficient to conclude that scientific theories were discovering the real nature of objects in themselves. In contrast, Kant denied any possibility of knowledge of these objects. For Whewell, a philosophy for scientific method must account for the unpredictable ways that scientific knowledge arises. These scientific discoveries could not be adequately explained as scientific truths if constitutive knowledge is limited to Kant's categories of the understanding. Whewell's account of science does not treat constitutive and regulative principles as different in kind, but only different in degree. *Pace* Kant, he argues that regulative judgments can become constitutive. I examine the principles of Whewell's philosophy of science such as the 'colligation of facts' and the 'consilience of inductions' and consider Whewell's theological justification for his account. This justification is problematic from the perspective of Kant's critical philosophy because Kant argued that knowledge of the existence of God was beyond the remit of theoretical knowledge. This helps us to critically examine contemporary Kant scholarship that argue in support of the benefits of incorporating Kantian principles into scientific methodology. I argue that these accounts require that we overlook certain incompatibilities between Kant's transcendental idealism and contemporary philosophy of science. Finally, accounts of consilience in contemporary philosophy of biology are examined to show how consilience has been transformed from a methodological principle that Whewell developed into a metaphysical principle. Rather than demonstrating truth in virtue of its unexpectedness, it has become a metaphysical demand that all nature must be reducible to a single unified scientific explanation of the world.

Chapter four considers Whewell's influence on Darwin. The two significant influences on the methodology of Darwin's theory of natural selection are Herschel and Whewell. Whewell's primary influence on Darwin was Darwin's commitment to the principle of consilience. Darwin emphasised the capacity of the theory of natural selection to provide a unified explanation of the origin of species. Whewell's account of biological entities, which was influenced by Kant, was less significant on the development of Darwin's account. Whewell transformed Kant's discussion of teleological judgment into justification for the ability to perceive God's divine plan. This meant that Darwin

remained unaware of the aspects of Kant's account of teleological judgment that conflicted with his account such as the analogy between artificial and natural selection. Darwin deployed this analogy because of the influence of Paley's theological explanation of the apparent design of organisms. Darwin accepted that organisms appeared *as if* they were designed, and argued that our ability to breed species to promote certain selected traits was analogous to nature's ability to select traits that promoted survival and reproduction. Kant denied the analogy between artefacts and organisms on the basis that organisms are judged to possess the capacity for self-organisation of their parts and wholes, whereas artefacts lack this capacity and depend on an external source for their organisation. I examine the debate between Ruse and Richards considering the extent to which Darwin's theory of natural selection should be considered as a mechanistic account. For Ruse, Darwin was fundamentally committed to a mechanistic account of nature, yet he argues that Darwin considered nature *as if* it were the product of design. He argues that Darwin would have agreed with Kant's conception of teleological judgment as a heuristic principle. This appeal to Kant overlooks significant incompatibilities between the accounts of Kant and Darwin. For Kant, the possibility of the conception of organisms depends or our ability to judge nature teleologically, it is not heuristic in the sense that we *choose* to apply such judgments to experiences of organisms to allows to examine them *as if* they are designed. Rather, Kant argued that teleology was a necessary precondition for the possibility of experiencing organisms. From this discussion of Kant and Darwin, I consider how the status of design has changed in contemporary philosophy of biology. Gould and Lewontin criticise adaptationism because of its underlying assumption that the purpose that a trait currently serves is causally responsible for the emergence of that trait. Ratcliffe has also argued that Dennett's adaptationist account requires a Kantian non-naturalistic foundation to make it possible to conceive of nature *as if* it were intentionally designed. In contrast other philosophers of biology have argued that organisms do not need to be understood in accordance with design. It has been argued that organisms should not be understood as similar to machines, instead they share more similarities with non-organic dissipative structures such as whirlpools. I argue that this solves the problem of the design of organisms at the cost of distinguishing between organic and non-organic entities.

Chapter five examines three cases in philosophy of biology that have appealed to aspects of Kant's philosophy in support of their accounts. First, Dupré indicates that his

account of biological freedom is minimally compatible with Kant's morality on the basis that both regard the subject as the source of action. Dupré argues that collective human action has been a source of major evolutionary change that cannot be accounted for according to reductive genetic accounts of biology. He suggests that widespread access to healthcare and education are examples of this. I argue this is broadly compatible with Kant's political philosophy which suggests that the state has a responsibility to ensure that the minimal needs of all citizens are supported. The fundamental difference between the accounts of Dupré and Kant is that the latter develops an account of the responsibilities of the state which is inseparable from the broader context of transcendental idealism. Second, I examine contemporary accounts of biological autonomy that appeal to Kant's discussion of teleological judgment in the Third *Critique*. These biologists argue that Kant correctly identified how organisms possess the properties of self-organisation. I argue that Kant's account of teleological judgment is inseparable from the broader context of his critical philosophy. I consider the connection that Kant establishes between moral teleology and physical teleology: he argues that the former makes good on the defects of the latter. This serves as the basis for my argument that Kant thought that our ability to conceive of organisms in nature is inseparable from our capacity for practical reason. Finally, I examine Kant's influence on the development of immunology. It has been argued that the development of immunology derived the basis for the distinction between self and non-self from Kant's account of self-knowledge of our own embodiment. I argue that this is based on an equivocation of two different conceptions of Kant's account of the self: the transcendental unity of apperception on the one side, and the self as embodied on the other. The conditions for each of these kinds of self-knowledge are significantly different and cannot be reconciled. Different conceptions of immunological identity have been proposed such as Pradeu's continuity theory. The continuity theory rejects the immunological conception of the self, instead it argues that the organism is a combination of endogenous and exogenous entities that are a tolerated by a single immune system. I consider how this conception of immunity develops from notion of physiological individuality that originates from Kant's conception of teleological judgment. This exposes how the features of organisms that Kant identifies as products of teleological judgment are also necessary for the account of the organism developed by the continuity theory.

Chapter One: Understanding influence: the role of transcendental idealism for the development of biology

Introduction

This chapter examines accounts of Kant's influence on the development of biology. Crucially, the influence of transcendental idealism on biology was only possible because biologists misunderstood transcendental idealism. This does not mean that transcendental idealism is useless for biology; instead biologists appealed to Kantian principles to resolve issues that went beyond their commitment to naturalism. These principles were deployed in an unwarranted manner according to Kant's critical philosophy. I examine Lenoir's argument that the development of 19th Century German biology essentially emerged from Kant's account of teleological judgment in the Third *Critique*. Lenoir's account has been subject to criticism by Zammito (2012); he has argued more generally that the fundamental differences between transcendental idealism and naturalism are insurmountable as biology is grounded on the principles of naturalism 'and Kant simply cannot be refashioned into a naturalist' (Zammito, 2006, p.749). By examining the conceptions of influence held by Zammito and Lenoir, I argue that both impose a strong level of similitude as a precondition for influence. The result is that neither can adequately account for how an influence can arise from misunderstanding. This leads Zammito to conclude that no such influence could arise, whereas Lenoir appeals to Lakatos' conception of research programs which protects the influence of transcendental idealism on biology from criticism. The investigation of Kant's influence on biology must be separated from questions pertaining to the warrant or compatibility of this influence. I argue that Kant's influence on biology is in tension with biology insofar as it is based on a misunderstanding of his philosophy, but an influence has nonetheless occurred. I consider alternative accounts, such as those proposed by Feyerabend and Bloom, that recognise how influence can arise from misunderstanding or misprision. This chapter is a ground clearing exercise in order to allow for a methodology of understanding influence that makes it possible to appreciate the importance of the role that misunderstanding can play in the development of scientific theories.

Kant's relationship with the philosophy of science has been complicated by interpreters, such as Strawson, who argued that Kant's critical philosophy should be regarded as subservient to our best scientific knowledge. Strawson reinterprets transcendental idealism from the perspective of what he terms the 'scientifically minded philosopher'. Strawson's account approaches the incompatibilities between transcendental idealism and naturalism by focusing on the areas of Kant's philosophy which are relevant to contemporary philosophical issues. I argue this disarms much of the critical force of transcendental idealism by reducing it to an outdated and encumbered metaphysical system. This is discussed in the first section.

The second section assesses the relation between influence and theory for history and science. It begins by outlining Berlin's examination of the different treatments of facts and theories in relation to science and history. Berlin regarded history as deficient to science in many ways as he argues that science is directed toward a single rational explanation of reality. This discussion serves as a basis for understanding the context of science from which Kuhn emerged. *Pace* Berlin, Kuhn's historical treatment of science reveals that science is not a single rational explanation of reality. Instead, the history of science has been marked by revolutionary 'paradigm shifts'. This is compared with Kant's account of political revolutions to consider potential objections that can be raised against Kuhn from the perspective of transcendental idealism.

The third section examines Lakatos' account of research programs as a response to the limitations of Kuhn. For Lakatos, research programs explain how science has internal mechanisms for directing research away from the essential aspects of theories. Instead research is directed toward hypotheses that will not bring the whole theory into doubt if research produces anomalous results. Lakatos is of specific importance in the context of Kant's influence on biology because Lenoir appealed to his conception of research programs as a framework for interpreting Kant's influence on the development of 19th century German biology. Hence, the discussion of Lakatos is preparatory for understanding Lenoir's account. I examine the controversy generated by the Lenoir thesis and the broader implications this has for understanding Kant's influence on biology. These criticisms of Lenoir should be understood as criticisms of his commitment to Lakatos' theory of research programs, not Kant's influence on biology. This demonstrates how Lakatos' theory of influence is too restrictive to adequately account for Kant's influence on biology.

In the final section, alternative accounts of influence are examined which can explain how Kant influenced biology despite their misunderstanding of his philosophy. According to Bloom's account of poetic influence, poets intentionally misunderstand or creatively correct their predecessors to establish their own identity as poets. Bloom argues that the history of poetry consists in tracing these creative misunderstandings or misprisions. Similarly, Feyerabend emphasises the importance of creativity for influence by appealing to the distinction between the context of discovery and the context of justification. I argue that these accounts reveal how Zammito is incorrect to infer the irrelevance of Kant's philosophy for contemporary philosophy of biology from their misunderstanding of Kant. Moreover, this resolves Zammito's own inconsistency on this issue when he asserts that '[o]nly by misunderstanding Kant did biology as a special science emerge at the close of the eighteenth century' (Zammito, 2006, p.765). This misunderstanding, both in the development of biology and in contemporary philosophy of biology, has allowed philosophers and scientists to utilise concepts that go beyond the limits of their commitment to naturalism.

1. Transcendental idealism as subservient to the scientifically minded philosopher

Over the past half a century, Strawson's interpretation of Kant has played a significant role in the rejuvenation of interest in Kantian philosophy in the English-speaking world. However, his account significantly reinterprets aspects of Kant's philosophy to focus on issues that are relevant for contemporary philosophy. This section offers a defence for transcendental idealism against aspects of Strawson's interpretation of Kant. I examine Strawson's criticism of Kant's separation of appearances from things in themselves, and his rejection of Kant's conception of the self as the transcendental unity of apperception. Finally, I argue that Strawson's approach to Kant's philosophy is susceptible to what Kuhn terms the problem of translation.

1. The scientifically minded philosopher and the relation between appearances and things in themselves

This section examines Strawson's objection to Kant's conception of things in themselves on the basis that it is no longer accepted by our best scientific understanding. I contrast Strawson's interpretation with Allais' account of Kant as a moderate metaphysical realist. She argues Kant's denial of knowledge of things in themselves is compatible with the aims of philosophers of science. Finally, I consider how these interpretations of Kant relate to debates regarding the relationship between experience and metaphysics within contemporary philosophy of biology.

Kant's denial of the correspondence between appearances and things in themselves is often cited as a source of disparity between transcendental idealism and contemporary philosophy. Strawson argued that this aspect of Kant's philosophy stands opposed to our best scientific understanding:

> The scientifically minded philosopher does not deny empirical knowledge of those things, as they are in themselves, which affect us to produce sensible appearances. He only denies that the properties which, under normal conditions, those things sensibly appear to us to have are included (or are all included) among the properties which they have, and which we know them to have, as they are in themselves. But Kant denies the possibility of any empirical knowledge at all of those things, as they are in themselves, which affect us to produce sensible experience. It is evidently consistent with, indeed required by, this denial to deny the physical objects of science are those things, as they are in themselves, which affect us to produce sensible experience.
>
> (Strawson, 1966, pp.40-1)

The transcendental idealist cannot assume that our scientific knowledge relates to properties of the objects 'as they are in themselves'. Strawson correctly identifies that transcendental idealists must reject the possibility that objects of science are things in themselves. Kant denies that our experience relates to such objects because experience is the product of the faculties of sensibility and understanding. Space and time are not properties of objects as they are in themselves, rather they belong to the faculty of sensibility. For Strawson, the transcendental idealist must accept that the faculty of sensibility does not produce space and time, if they do not then they are committed to the position that things as they really are, in themselves, are not in space and time. Strawson denies this possibility: '[t]hings, as they really are, are not removed from the spatio-temporal framework of reference. They are simply things as science speaks of them rather than as we perceive them' (Strawson, 1966, p.252).

Strawson argues that transcendental idealism results in the problem of affection. The problem of affection consists in Kant's denial that we can know anything about the origin or cause of experience because we can only know the content of experience (Strawson, 1966, pp.40-1). Importantly, Kant did not regard this as a problem as the thing in itself 'is never asked after in experience' (CPR A30/B45). The origin of experience—as an object independent of experience—is not given in experience. It is not possible to enquire into the origin of our faculties because this would require us to presuppose that space and time existed independently from the faculty of sensibility.

For Kant, space and time are both empirically real and transcendentally ideal. This means that any object of experience is empirically real insofar as it is an appearance, but we cannot provide an explanation of any empirical object that goes beyond what is given in appearance; 'it is nothing at all if one abstracts from the subjective conditions of sensible intuition' (CPR A35/B52). Strawson disregards this aspect of transcendental idealism when he explains experience as causally dependent on the relation between our physiology and things in themselves. We are primarily creatures, as opposed to finite rational beings, that are already *in* time and space as we each have a history and a bulk (Strawson, 1966, p.242).

In contrast to Strawson, Allais' interpretation offers a more sympathetic account of both Kant's rejection of knowledge of objects as they are in themselves and the need for such knowledge in contemporary philosophy of science. Allais describes her interpretation as a 'moderate metaphysical realism'. According to Allais, 'the things of which we have knowledge have a way they are in themselves that is not cognizable by us, […] the appearances of these things are genuinely mind-dependent, while not existing merely in the mind' (Allais, 2015, p.9). Importantly, she argues that this aspect of Kant's philosophy is potentially compatible with philosophy of science. The contents of science are generally directed toward an empirically observable reality. Allais interprets Kant as saying that 'the things of which we have experience are the things that are described by science, what we know through science counts as part of possible experience, and neither science nor perceptual experience gives us knowledge of an unobservable reality' (Allais, 2015, p.219).

In this sense, Allais reverses Strawson's charge that Kant's philosophy is counterintuitive because it denies knowledge of things in themselves. Her argument is

that the aims of science and Kant's theoretical philosophy are compatible insofar as neither is concerned with demonstrating the existence of entities in a reality which cannot be observed. Therefore, Kant's rejection of knowledge of things in themselves is consistent with contemporary philosophy of science. Moreover, this reversal entails that it is more counterintuitive for scientific justification to appeal to anything that is essentially unobservable.

There is widespread agreement that science should relate to observable experience, but Allais' interpretation entails the stronger stance that science lacks the warrant to make claims about that which is unobservable. In this context, the relation between science and unobservable reality could be understood in two ways; either science *does* not talk about unobservable reality, or it *should* not. The former would be problematic as many contemporary debates in the philosophy of science discuss entities that are unobservable. For instance, consider the debate between metaphysical monism in opposition to metaphysical pluralism. For Dupré, scientific monism is committed to metaphysical assumptions about the underlying scientific unity of nature which lacks sufficient empirical grounds (Dupré, 2012, p.30). In contrast, he argues that there is greater empirical support for conceiving of nature as ontological processes which can be more appropriately explained in accordance with metaphysical pluralism. According to Dupré and Nicholson,

> metaphysics is generally to be established through empirical means, and is ultimately therefore answerable to epistemology. Scientific and metaphysical conclusions do not differ in kind, or in the sorts of arguments that can be given for them, but in their degree of generality and abstraction. (Dupré and Nicholson, 2018, p.4)

It is important to emphasise that this definition of metaphysics is significantly different to traditional conceptions. Aristotle defined metaphysics as 'first philosophy', or the study of 'being *qua* being' (Aristotle, 1908, 1003b-1004a). This separated metaphysics from experience. In contrast, philosophers of science such as Dupré approach metaphysics as inherently related to empiricism; in this context, it could more appropriately be termed 'being *qua* experience'. This emphasis on the connection between experience and metaphysics does not entail that contemporary philosophers of science endorse Kant's denial of knowledge of entities independent of perception. Dupré and Nicholson argue they are compelled to understand the world more generally in terms

of universal processualism. However, they concede that the evidence for such a view can only be developed in a 'piecemeal' way.

This raises some important difficulties when considering the potential relationship between Kant and contemporary philosophy of biology. On the surface, it seems that the emphasis on experience as a condition of knowledge indicates a potential compatibility between their accounts. Yet, the relation between experience and metaphysics is significantly different for each. Kant was critical of the idea that metaphysics could develop in accordance with anything other than a systematic method. Despite the growing empirical evidence for process biology and pluralism, Kant would deny any metaphysical account that was developed in a piecemeal or fragmentary manner. Kant begins his 'Metaphysical Principles of the Doctrine of Virtue' with the following definition of metaphysics:

> A philosophy of any subject (a system of rational cognition from concepts) requires a system of pure rational concepts independent of any conditions of intuition, that is, a *metaphysics* […] *so that it can be set forth as* a genuine science (systematically) and *not merely as an aggregate of* precepts sought out one by one (fragmentarily).
>
> (MM 6:375)

Kant's hostility toward developing a metaphysics in a fragmentary or piecemeal manner creates a significant tension between Kant's critical philosophy and many philosophies of science. In this sense, the restrictions that Kant imposes on the appropriate method for scientific enquiry has significant implications for understanding Kant's relationship with contemporary philosophy of science. These restrictions are potentially much greater than many contemporary philosophers of science would concede.

This brief account of Strawson's and Allais' interpretations of the relation between things in themselves and appearances has introduced some of the difficulties relating to ontology and epistemology in contemporary philosophy of biology.

2. Strawson's account of the self

Another important aspect of Strawson's interpretation of Kant is his treatment of Kant's conception of the self. Strawson regards Kant's transcendental unity of apperception physiologically, rather than transcendentally. He asserts that 'self-consciousness must […] belong to the history of […] a being which *has* a history and hence is not a supersensible being' (Strawson, 1966, p.248). In contrast, Kant argued that the self-

consciousness of the unity of apperception was not historical, rather it was a transcendental presupposition for the possibility of consciousness as belonging to a self. The physiological explanation of the self makes an epistemic leap that cannot be justified according to the principles of transcendental idealism. Kant emphasises that 'consciousness of the self is very far from being a knowledge[2] of the self' (CPR B158). Explaining the self physiologically transforms our knowledge of the self into a historical examination of its physiological emergence.

This tension between transcendental and physiological explanations exposes a difficulty for understanding Kant's potential influence on biology. Kant argued that transcendental conditions of experience could not be derived physiologically, yet he also drew from biological ideas of his time to explain transcendental idealism. He required an explanation of the faculty of pure reason that did not implicate reason as emerging from either God or nature. The biological notion of epigenesis was instrumental for this explanation. However, in its biological context, epigenesis could not grasp how the system of pure reason could emerge without itself being part of nature.[3] Hence, Kant argued that epigenesis was not concerned with nature but with the epigenetic emergence of the system of pure reason (CPR B167). According to Mensch, '[o]nly "the epigenesis of reason," as appealing neither to experience nor to God but only to itself, could finally serve as the ground for experience' (Mensch, 2013, p.139). From Strawson's account, we might assume that Kant was not aware that physiological explanations can now replace transcendental explanations because they are supported by our best scientific understanding. Kant was aware of physiological explanations, however he thought that such explanations were unable to grasp the properties that are specific to our capacity for reason. In his criticism of Locke, Kant argued against any possibility of deriving the rational features specific to transcendental idealism physiologically:

> I therefore call this attempted physiological derivation, which cannot properly be called the deduction at all because it concerns a *questio facti*, the explanation of the **possession** of pure cognition. It is therefore clear that only a transcendental and never an empirical deduction can be given, and that in regard to pure *a priori* concepts empirical deductions are nothing but idle attempts, which can occupy only those who have not grasped the entirely

[2] This is from Smith's translation as the term 'Erkenntnis' is translated as knowledge, whereas Guyer and Wood translate this as cognition.

[3] The difference between the transcendental and biological accounts of epigenesis is emphasised by Quarfood: '[n]obody believes that transcendental idealism is based on geography just because CPR contains geographical analogies, and likewise it should be clear that an epigenetical account of the categories is not part of the biological theory of epigenesis' (Quarfood, 2004, p.102).

distinctive nature of these cognitions.
(CPR A86-7/B119)

Strawson assumes that the scientifically minded philosopher has achieved what Kant thought was impossible, namely that physiological or biological explanations could take the place of transcendental explanations. However, physiological and biological explanations are not as certain as Strawson would have us believe. The limit of biological explanations is still an important issue for contemporary philosophers of biology. According to Kauffman, 'there may be a limit to the way Newton taught us to do science and a need to reformulate what we do when we and other agents get on with living a life. […] [I]t appears something profound is going on in the universe that is not finitely prestatable' (Kauffman, 2000, p.50). This realisation of the possible limit, or an unrealistic expectation, of scientific explanation resonates with Kant. Kant also denied any possibility that 'there may yet arise a Newton who could make comprehensible even the generation of a blade of grass according to natural laws that no intention has ordered' (CJ 5:400). Kant addresses the limitations of biological explanations in the second part of his Third *Critique*; however, his route to this discussion is inseparably entangled with his critical philosophy. In the context of the First *Critique*, the appeal to the epigenesis of reason reinforces the barrier between reason and nature as it suggests that reason could not be understood as emerging from nature, which is further developed in his later work. According to Mensch, '[e]pigenesis thus served as a resource for a *metaphysical* portrait of reason, even as it was denied determinate efficacy in the world of organisms' (Mensch, 2013, p.144). This exposes the fundamental issue regarding the relationship between transcendental idealism and biological naturalism. For Kant, reason cannot be located temporally (historically) or spatially (physiologically). Understanding Kant's potential influence on the development of biology will require us to address this incompatibility.

This discussion of aspects of Strawson's account has indicated how transcendental idealism could oppose the physiological emergence of the self. Kant's rejection of physiology is not a mere historical oversight of his critical philosophy that should now be considered as subservient to these scientific developments. For Kant, physiology is not sufficient to explain the development of mankind. This explanation requires that we examine human action and character. According to Kant, the history of man is 'to be found neither in metaphysics nor in a museum of natural history in which the skeleton of man can be compared with that of other kinds of animal' (HR 8:56). Kant's conception of the self is not reconcilable with the physiological account of the self.

3. Strawson and the problem of translation, transcendental idealism and transcendental realism

The shortcomings of Strawson's account of transcendental idealism can be understood by analogy with Kuhn's conception of the untranslatability between scientific paradigms. Kuhn describes how the history of science is essentially comprised of independent scientific theories or paradigms that cannot engage with one another on their own terms. Kuhn uses the connotations of translation to explain this; '[t]o translate a theory or worldview into one's own language is not to make it one's own. For that one must go native, discover that one is thinking and working in, not simply translating out of, a language that was previously foreign' (Kuhn, 1970a, p.204). Strawson simply does not approach Kant's philosophy as a native. Kuhn explains that the largest obstacle for historians of science is appreciating the context under which the works they examine are produced. Any historical understanding must attempt to engage with the ideas that they are studying as a native, even if this is not ultimately achievable. Strawson's approach regards the presuppositions of the 'scientifically minded philosopher' as a lens for identifying the relevant features of Kant's work. According to Allison,

> Strawson's way of formulating Kant's argument is fundamentally misleading. Kant is not maintaining that because we don't know "real" objects (things in themselves) we have to make do with some kind of subjective "Surrogate", but simply that the basis upon which the mind judges, the ground of its recognition of an objective world as distinct from itself is ultimately one of coherence. Rather than a "Surrogate" he is offering us a transcendental re-interpretation of what is meant by the real. (Allison, 1969, p.224)

Strawson transforms transcendental idealism into a transcendent metaphysical position. For Allison, this led Strawson to regard Kant's claims about transcendental idealism as simultaneously transcendent metaphysical claims. Allison describes this as a 'transcendent conception of the transcendental' (Allison, 1969, p.231). The meaning that is captured in this description needs unpacking. Kant contrasted transcendental idealism with transcendental realism. For transcendental realists, space and time are not merely conditions of phenomenal experience, rather they are ontological metaphysical features of objects. They regard our representations of objects to pertain to objects in themselves because they apply the 'modifications of our sensibility into things subsisting in themselves' (CPR A491/B519). Transcendental realists make transcendent claims that cannot be supported by reference to any experience whatsoever. Their claims are beyond

any possible empirical justification and therefore Kant argues that these are dogmatic claims. When metaphysical disputes arise between transcendental realists, neither side can justify their position with empirical support. For Kant, the contents of their speculations are merely machinations that arise out of private vanity (CPR A749/B777) with no regard for truth. Disputes between transcendental realists result in contradiction because they rely on assertions concerning states of affairs 'which neither of them can exhibit in an actual or even possible experience' (CPR A750/B778).

Transcendental realism is concerned with questions about being that are beyond the boundaries of knowledge, whereas transcendental idealism is concerned with the conditions that make claims of knowledge warranted. Allison succinctly explains this difference; '[i]nstead of the traditional concern of metaphysics with the nature of being, it [i.e., transcendental idealism] advocates the primacy of the concern with the conditions of our knowledge of being' (Allison, 1969, p.217). Any philosophy that does not acknowledge the discursive foundations of knowledge is committed to transcendental realism, 'which is to say every philosophy except transcendental idealism' (Allison, 2008, p.279). Allison argues that the number of philosophies included under transcendental realism, many of which would not be traditionally understood as 'realisms' at all, suggests that Kant did not regard transcendental realism as a metaphysical thesis. According to Allison, 'if transcendental realism is not a metaphysical thesis then neither is transcendental idealism, since Kant presents them as contradictory opposites' (ibid). Clearly, specific transcendent realist accounts are committed to certain metaphysical theses, yet transcendental realism in general cannot be understood as a single metaphysical thesis because alternative transcendental realist accounts are contradictory. Their commonality is that they all share a commitment to the idea that the conditions of experience are also conditions of objects as they are in themselves. In contrast, the methodological commitment of transcendental idealism is directed toward exposing the conditions of knowledge. It is a method, rather than a metaphysics, which focuses on the implications of specific orientations in thinking. In his article 'What Does it Mean to Orient Oneself in Thinking?', Kant highlighted how his critical philosophy made it possible to expose the limitations of alternative philosophies by means of their orientation. Kant asserts that '[o]ne remains safe from all error if one does not undertake to judge where one does not know what is required for a determinate judgment' (OT 8:136). Transcendental idealism, understood as an orientation or methodology, is not

metaphysical in the same way as transcendental realism and does not advocate a transcendent metaphysics.

Strawson's account prioritises transcendent metaphysical claims over transcendental idealism because of his emphasis on physiological explanations. Physiological explanations require metaphysical assumptions that cannot be permitted by transcendental idealism, namely, that space and time are prior to experience as conditions of physiological development. Transcendental idealism is not metaphysical in this sense because it opposes the notion that we can attain knowledge of entities independent of experience by regarding them *as if* they were appearances.[4]

In summary, this section has examined some essential aspects of Strawson's interpretation of Kant and considered how transcendental idealism could defend itself against Strawson's accusations. Strawson reduces Kant to a figure who should be respected because of his achievements despite working under the constraints of an inherently flawed system. He concludes: '[t]hat he conducted the operation under self-imposed handicaps—though not in itself a matter for congratulation—makes it more remarkable that he achieved so much' (Strawson, 1966, p.272). Yet transcendental idealism can expose important metaphysical assumptions for Strawson's scientifically minded philosopher that are not sufficiently supported.

2. The role of influence and theory for history and science

This section examines how the understanding of the relation between influence and theory has changed within the philosophy of science. First, I examine Berlin's account of the difference between the use of theory in science and history. Then I consider how Kuhn's account of scientific revolutions exposes many assumptions within Berlin's account that leads him to regard historical theory as deficient in relation to scientific theory. Kuhn demonstrates how science does not culminate in a single rational theory as Berlin

[4] Kant does engage with metaphysical questions regarding the freedom, immortality and the soul, however he does not think that transcendental enquiries into these questions necessitate treating them as appearances. This is discussed in Chapter Five (1.3)

suggested. This provides a context for understanding Lenoir's account of Kant's influence on the development of German biology in the 19th century in the next section.[5]

1. Berlin and Kuhn on the relation between history and science

Berlin compared the methodologies of history and science and argued that history could not become a science because science was governed by rational principles. Science aimed at providing a single correct account of reality. Berlin compared the structure of science with history in his article 'History and Theory: the concept of Scientific History'. Berlin presents the account of science that was predominant leading up to the publication of Kuhn's *The Structure of Scientific Revolutions* which brought into question many aspects of scientific methodology that were taken for granted by Berlin.

Berlin regarded historical methodology as deficient to scientific methodology as the latter exemplified a rational and logical structure which the former lacked; 'natural science is nothing if it is not a systematic interlacing of theories and doctrines, built up […] [b]y the most competent practitioners in the field' (Berlin, 1998, p.27). The fundamental difference between these methodologies related to a difference in their treatments of facts in relation to theories. Historians regard facts as having a greater refutational power over their theories than scientists. Berlin argues that if a scientist had attempted to watch the sunrise, but the sun did not rise as had been expected, then it would be premature for the scientist to doubt the succession of day and night, or even our entire understanding of celestial mechanics, based on this experience alone. Scientists tend to look for additional reasons (or auxiliary hypotheses) that, if proven correct by additional experimentation, would account for the failure of the expectation of this experiment whilst remaining consistent with the theory overall. In contrast, historical methodology does not place the same level of certainty in the theories that it prescribes. Consider the following example: a historian has a theory which forbids French generals to go into battle wearing a three-cornered hat, but the historian also possessed evidence that 'Napoleon had been seen in a three-cornered hat at a given moment during the battle of Austerlitz' (Berlin, 1998, p.27). Berlin argues that the historian should not continue to believe their theory considering this evidence: 'addiction to theory—being doctrinaire—is a term of abuse applied to historians; it is not an insult if applied to a natural scientist' (ibid). He

[5] In the next section I examine how Lenoir appeals to Lakatos' account of influence to understand Kant's influence on biology. Lakatos was building on Kuhn's account in various ways. See Chapter One (3.1)

argues that history is not scientific because it does not approach nature systematically. Berlin described history as a 'skill' or an 'empirical knack' because the success of the historical account depends upon the judgment and skill of that historian. In contrast, the success of a scientist is not dictated by skill, or even intelligence, as they rely on theories. According to Berlin, '[a] man who lacks common intelligence can be a physicist of genius, but not even a mediocre historian' (Berlin, 1998, p.57).

Kuhn's examination of the history of science provided an alternative perspective on these aspects of science. He argued that scientific practitioners are dependent on the methodological principles that are specific to a paradigm. The specialist level of training that is required for any novice scientists in the field equips them to identify and solve puzzles or problems that are related to a certain paradigm. Only by completing this training can a scientist gain membership of that paradigm.

There are many reasons why scientists seem to have a greater level of immunity toward anomalies arising from their theories than historians. The experimental and methodological boundaries of their paradigm will inform their investigation of nature. This makes it less likely that an anomaly will arise within the specific variables that are investigated in any experiment. Moreover, the primary motivation for a scientific experiment is that it will validate some aspect of a theory, hence the relevant variable outcomes are established prior to the experiment. Kuhn describes this as 'normal science'. Normal science is a process of 'filling-in the gaps' of a pre-established paradigm, it is 'mopping-up' the aspects of a paradigm that do not have sufficient empirical support:

> Mopping-up operations are what engage most scientists throughout their careers. They constitute what I am here calling normal science. Closely examined, whether historically or in the contemporary laboratory, that enterprise seems an attempt to force nature into the preformed and relatively inflexible box that the paradigm supplies. No part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit in the box are often not seen at all. Nor do scientists normally aim to invent new theories, and they are often intolerant of those invented by others. Instead, normal-scientific research is directed to the articulation of those phenomena and theories that the paradigm already supplies. (Kuhn, 1970a, p.24)

Both Berlin and Kuhn agree that a scientific practitioner lacking common intelligence could be regarded as a great scientist, but Kuhn emphasises this is because normal science is opposed to critical discourse; 'it is precisely the abandonment of critical discourse that marks the transition to a science' (Kuhn, 1970b, p.6).

Feyerabend takes issue with this uncritical aspect of Kuhn's description of normal science. He compares normal science with organised crime and lists the following similarities. Like scientific practitioners, safebreakers are solving puzzles in accordance with their expectations of phenomena. They also develop special-purpose tools for solving these puzzles. In the event of failure, the inadequacy of an individual safebreaker is blamed rather than the theory. According to Feyerabend, '[w]herever we look – the distinction we want to draw does not exist' (Feyerabend, 1970, p.200). This comparison reveals important differences between the conception of scientific practice for Kuhn and Berlin. For Kuhn, scientists are informed in the context of a paradigm that they follow uncritically when they engage in normal science. The aspects of scientific theory that Berlin regards as lacking in historical theory are merely manifestations of the uncritical structure of science.

Berlin also appeals to the differing uses of language for historical and scientific textbooks to demonstrate how scientists achieve a certainty that is lacking for historians. The historian weaves together logically independent concepts and events in their attempts to explain how they are causally related. For scientists, the situation is precisely the opposite; in a textbook of physics or biology 'the links between the propositions are, or should be, logically obvious' (Berlin, 1998, p.31). The conviction of the correctness of explanations that scientific theories yield does not depend on the rhetoric and skill of any single scientist. The explanation is considered as correct because it can be logically demonstrated. Even if the language which implied the inference (such as because, therefore, hence, etc.) were removed from all scientific textbooks, the theory should still be able to demonstrate its inner logical structure. In contrast, if this were to happen in all history textbooks,

> the bald juxtaposition of events or facts would at times be seen to carry no great logical force in itself, and the best cases of some of our best historians (and lawyers) would begin—to the mind as conditioned by the criteria of natural science—to seem less irresistible
>
> (Berlin, 1998, p.32)

For Kuhn, the function of the rational and logical structure of scientific textbooks is pedagogical. When one scientific paradigm is replaced by another, then the textbooks must be re-written. According to Kuhn, textbooks 'have to be rewritten in the aftermath of each scientific revolution, and, once written, they inevitably disguise not only the role but the very existence of revolutions that produced them' (Kuhn, 1970a, p.137). Scientific

textbooks establish their logical and rational rigour at the cost of their commitment to historical accuracy: '[f]rom the beginning of the scientific enterprise, the textbook presentation implies, scientists have striven for the particular objectives that are embodied in today's paradigms' (Kuhn, 1970a, p.140). *Pace* Berlin, science only *appears as* a single unified logical account of reality because of the pedagogical function of the unity of science.

The pedagogical function of scientific textbooks is to reinterpret the history of science to establish a false similitude between the research interests of their current paradigm and the interests of previous scientific theories. They claim that the puzzles of contemporary science have also been the puzzles of previous scientific paradigms, yet previous scientists did not realise this. They present their theories as finally articulating the puzzles that scientists have been tackling for centuries (if not millennia). This prevents practitioners of the current paradigm from viewing themselves as representatives of yet another paradigm that will eventually be 'overthrown' by a currently unfathomable theory. They view their own paradigm as different because it has answered the questions that have persisted throughout the history of science.

There are many examples that support Kuhn's analysis of this function that scientific textbooks serve. For instance, Mayr argued that Aristotle's conception of *eidos* 'was conceptually virtually identical with the ontogenetic program of the developmental physiologist' (Mayr, 1982, 56). Similarly, Ruse compares Darwin with the contemporary 'selfish gene' supporters; 'Darwin didn't know about genes, so he could not be a "selfish gene" supporter, but he was as close to that as it is possible to be' (Ruse, 2016b, p.181). Such statements potentially distort historical figures who have contributed to the development of science because it subjects them to the considerations of contemporary science. They serve to implicitly support the idea that science is progressive because the problems identified by the contemporary paradigm have persisted throughout the development of science, unbeknownst to the individuals who have supposedly endorsed these views. Richards, in opposition to Ruse, explains how interpretations of Darwin have tended to consider Darwin through the lens of contemporary biology:

> Even good historians have been blinded by the light of modern evolutionary theory when attempting to give an account of the historical Darwin. In that brilliant glow coming from our contemporary science, those historians have constructed his doppelgänger.
>
> (Richards, 2016a, p.115)

Strawson's interpretation of Kant is also susceptible to this criticism. He refused to examine the merits of transcendental idealism on its own terms, instead he approached it from the perspective of the 'scientifically minded philosopher'. Strawson's interpretation might be considered as inadvertently constructing Kant's doppelgänger. It is inadvertent because Strawson is clear from the outset that his account 'is by no means a work of historical-philosophical scholarship' (Strawson, 1966, p.11). Nevertheless the impact of Strawson's interpretation has been far-reaching and long-lasting with respect to Kant scholarship.

2. Scientific revolutions and incommensurability

Kuhn argued that the history of science comprises periods of normal science that are interrupted by scientific revolutions. Scientific revolutions occur when a scientific paradigm reaches a stage of crisis. A scientific paradigm reaches a stage of crisis when it can no longer solve puzzles in accordance with the parameters set out by that paradigm. At this point, the scientific theory becomes speculative in its attempt to solve these problematic puzzles. According to Kuhn, '[a]ll crises begin with the blurring of a paradigm and the consequent loosening of the rules for normal research' (Kuhn, 1970a, p.84). The identity of the paradigm is essentially the rules that are prescribed for its normal puzzle solving practices. Hence, this identity is jeopardised when it engages in speculation in an attempt to find solutions for these puzzles. Combined, the unproductivity of a paradigm and the loss of identity make the paradigm vulnerable to revolution. According to Kuhn, 'the single most prevalent claim advanced by the proponents of the new paradigm is that they can solve problems that have led the old one to a crisis' (Kuhn, 1970a, p.153). The new paradigm entails the destruction of the old; Kuhn states '[i]t is hard to see how new theories could arise without these destructive changes in beliefs about nature' (Kuhn, 1970a, p.98).

This image of the relation between paradigms is analogous to the image of a phoenix rising out of the ashes of its predecessor. A new paradigm is not accepted on the basis that it can offer a more complete explanation of the world than its predecessor; it is merely able to solve puzzles that its predecessor could not. The explanation of one scientific theory replacing another by means of revolution has been criticised on the basis that it reinforces the incommensurability between paradigms. According to Feyerabend:

> Revolutions bring about a *change* of paradigm. But following Kuhn's account of this change, or 'gestalt-switch' as he calls it, it is impossible

> to say that they have led to something *better*. It is impossible to say because pre- and post- revolutionary paradigms are frequently incommensurable. (Feyerabend, 1970, p.202)

The incommensurability of scientific theories is similar to an aspect of Leibniz's description of monads. Monads are atoms of pure existence that cannot communicate with one another. According to Leibniz, 'monads have no windows through which something can enter or leave' (Leibniz, 1989, p.214). One difference between the kinds of incommensurability expressed by monads and paradigms is that paradigms usually successively follow one another, whereas all monads exist simultaneously. Paradigms are windowless in the sense that they are not translatable into the terms of other paradigms. Scientific textbooks are used to cover up both the revolutionary context of the origin of paradigms and their incommensurability with other paradigms. One paradigm replaces another by means of revolution; however, this is not communication between paradigms but a forceful dethroning of one paradigm for another. According to Kuhn, members of different paradigms 'do in some sense live in different worlds' (Kuhn, 1970a, p.193).[6]

I end this section with a short comparison of the role of revolution in Kant's critical philosophy. Kant also considered the importance of revolution in both its philosophical and political or societal contexts. He endorsed the notion of scientific revolutions when he described the *Critique of Pure Reason* as analogous to the Copernican revolution (CPR Bxxii). This was meant to signify that transcendental idealism should be regarded as a break with previous philosophical accounts. In this sense, Kant regarded transcendental idealism as analogous with the notion of scientific 'paradigm shifts' that Kuhn described. Yet, Kant's conception of science was significantly different than Kuhn's; for Kant science was apodictically certain and universally true. According to Friedman, 'an absolutely universal human rationality realized in the fundamental constitutive principles of Newtonian science made perfectly good sense in Kant's own time, when the Newtonian conceptual framework was the only paradigm' (Friedman, 2002, p.183). In the context of contemporary philosophy of science

[6] Kuhn's claims regarding the untranslatability of scientific paradigms and that members of different paradigms live in different worlds has been criticised by Davidson. He argues that objective truth must relate to a world that is partially translatable between different languages and other kinds of conceptual schemes. According to Davidson, translation can only fail if 'there is something neutral and common that lies outside all schemes' (Davidson, 1973, p.12).

where there have been multiple paradigms, it might be argued that Kant's account is no longer relevant or desirable.[7]

Kuhn's account of science as a social activity makes it possible to offer an alternative comparison of their accounts of revolution. Kant's political philosophy, which was also socially oriented, can be compared with Kuhn's conception of scientific revolutions. Kant condemns political revolutions because they are not compatible with reason, whereas Kuhn draws upon political revolutions to support their role in science. He argues that political revolutions occur in cases where political systems cease to adequately resolve problems that negatively impact a sector of the community. In this sense, these political systems malfunction for those members of the community. According to Kuhn, '[i]n both political and scientific development the sense of malfunction that can lead to crisis is a prerequisite to revolution' (Kuhn, 1970a, p.92). He explains that political revolutions have had a vital role in the evolution of political institutions.[8] The function of revolutions is to establish a change which is prohibited by the political institution itself. Kuhn regards political revolutions as an exemplar of how scientific revolutions ought to function. In contrast, Kant argued that political revolutions were not compatible with reason as they prohibited the measure of progress. Political change must be carried out in accordance with *reformation*, not *revolution*. This allows us to continuously work on the aspects of the political institution that are malfunctioning without the cost of losing the aspects of a political system that are not malfunctioning. This is the only way to ensure that politics develops in accordance with reason. According to Kant,

> [Political change] should not be made by way of revolution, by a leap, that is, by violent overthrow of an already existing defective constitution […]. But if it is attempted and carried out by gradual reform in accordance with firm principles, it can lead to continual approximation to the highest political good, perpetual peace.
>
> (MM 6:355)

For transcendental idealism, the idea of political revolution is antithetical to the progress of reason. This is not because the political system replacing the current system will necessarily be worse; rather, overthrowing one system for another makes it impossible to judge whether that system is better. In this sense, Kant's argument against political

[7] For the purposes of this thesis, I am less concerned with the relevance of Kant's philosophy of science in contemporary philosophy, rather, I investigate the aspects of Kant's philosophy that have been influential on developments of biology in both its historical and contemporary contexts.
[8] What is meant by the 'evolution of political institutions' is not clear.

revolutions is that it results in the inability to measure progress arising from such revolutions as the two political systems are incommensurable.

This difference between Kant and Kuhn is also evident from their accounts of the difference between the descriptive and prescriptive aspects of science. Kuhn's account of the structure of science blurs the distinction between these aspects of science. Hence, the practices that scientists engage in, are also the practices that they ought to engage in (Feyerabend, 1970, p.198). In contrast, Kant separates the prescriptive and descriptive aspects of human activity. An investigation of how people act is anthropological, whereas an investigation into the way people ought to act is a matter for practical reason. This distinction allows Kant to separate the descriptive fact that political revolutions have occurred in a certain way, from the prescriptive claim that they ought to have occurred that way. Therefore, if Kant had considered the possibility that science was a social activity, I argue he would have opposed Kuhn's idea of scientific revolutions. In his political philosophy, Kant pre-empted the criticism against Kuhn that revolution came at the cost of incommensurability and the inability to measure progress.

In summary, this section has explored how the understanding of the methodologies of science and history has significantly changed. For Berlin, history lacked the rigorous systematic methodology of science. For him, the fundamental difference between these methodologies is that history depends on the sagacity and skill of individual historians. In contrast, he argued, discoveries in science do not depend on the language used to explain such discoveries as they are logically demonstratable. Kuhn's analysis of the structure of science radically transformed our understanding of scientific methodology. For Kuhn, the apparent systematicity of scientific methodology came at the cost of making normal scientific practice essentially uncritical. Scientists follow the rules of a particular paradigm blindly; they are engaged in mopping-up operations that neither promote the emergence of unexpected results nor make sense of such results if they arise. Feyerabend emphasised the uncritical aspect of Kuhn's account of science by comparing the activities of practitioners engaged in normal science to practitioners of organised crime. The incommensurability between different scientific theories is a consequence of Kuhn's argument that transitions in science are achieved by means of revolution. Different scientific paradigms at any one time are untranslatable to one another; a scientific practitioner can only move between paradigms by a process analogous to a conversion experience (Kuhn, 1970a, p.151). Scientific theories have pedagogical

mechanisms for covering-up the occurrence of these revolutions through textbooks that present the history of science as culminating in the problems that can be solved by the current paradigm. In relation to Berlin's account, this reveals how science distorts its historical emergence by suggesting that previous sciences were unconsciously engaged in the problems specific to contemporary science. Finally, I compared Kuhn's appeal to political revolutions as justification for scientific revolutions with Kant's account of political revolutions. Kant opposed political revolutions because they resulted in incommensurability and denied knowledge of any possible progress. Hence, Kant would have rejected Kuhn's account of scientific revolutions on the basis that his account stands in opposition to the rationality and progress of science.

3. The context of research programs and the Lenoir thesis

This section examines how Lakatos' account of research programs develops from the shortcomings of Kuhn's philosophy. Lakatos took issue with Kuhn's account of anomalies. For Kuhn, scientists approach anomalies blindly; in contrast Lakatos argues that scientists anticipate the impact of potential anomalies and direct their research accordingly. I outline Lenoir's appeal to Lakatos' conception of research programs in relation to his account of Kant's influence on the development of 19th century German biology. I examine criticisms of Lenoir's account and argue these should be understood as criticisms of Lenoir's appeal to Lakatos, rather than of Kant's influence on the development of biology more generally.

1. Lakatos' conception of research programs and the Lenoir thesis

This section examines Lakatos in the context of Kuhn to understand how his conception of research programs was intended to rectify Kuhn's philosophy of science. Lakatos' account effectively exposes important limitations of Kuhn's description of the structure and practice of science. In addition, Lenoir adopts Lakatos' conception of research programs as a guiding thread for understanding the historical influence of Kant on the development of 19th century German biology. Importantly, Lakatos builds on the foundations of Kuhn to develop a methodology of science that considers science to be

rational. His account of research programs must be discussed before examining its deployment within Lenoir's thesis.

Lakatos criticises the shortcomings of Kuhn's account of the structure of science on the basis that it had not sufficiently explained how science deals with the potential anomalies that arise during the activities of normal science. Kuhn had merely explained that anomalies were not an expected outcome of normal scientific activity, they emerged because of the difficulties regarding the 'paradigm-nature fit'. According to Kuhn, 'if an anomaly is to evoke crisis, it must usually be more than just an anomaly. There are always difficulties somewhere in the paradigm-nature fit; most of them are set right sooner or later' (Kuhn, 1970a, p.82). Science must be carried out in accordance with a paradigm, and paradigms are opposed to the discovery of unexpected evidence. In short, normal science opposes the emergence of novelty: 'novelty emerges only with difficulty, manifested by resistance, against a background provided by expectation' (Kuhn, 1970a, p.64). The occurrence of novelty entails that the expectations of the scientific community are wrong and the best instruments that we have for understanding the world are not fit for purpose. According to Kuhn, '[u]nanticipated novelty, the new discovery, can emerge only to the extent his anticipations about nature and his instruments prove wrong' (Kuhn, 1970a, p.96). Lakatos criticised Kuhn's account of anomalies because it did not consider how scientific method could be internally structured to target certain anomalies. For Lakatos, scientific methodology directs research toward anomalies that are more likely to be resolved and avoid anomalies that would be detrimental to the scientific paradigm or research program more generally. In other words, science has a method for anticipating the potential detriment of an anomaly and can direct research towards anomalies that are less detrimental.

Lakatos compares anomalies to an ocean. Without intervention, the ocean will erode a shoreline in much the same way that anomalies will erode a paradigm (or what Lakatos calls a research program). The erosion of the shoreline is prevented by creating coastal defences and redirecting this eroding force. Analogously, Lakatos argues that scientific theories have two distinct heuristic functions; they are called the positive and negative heuristics. The negative heuristics of a research program relate to the elements of a theory that scientific practitioners must subscribe to as a condition of identifying themselves as belonging to that research program. If these principles are abandoned or refuted, then the research program collapses. Scientific research is directed away from

any potential research that will bring these fundamental principles (the negative heuristic or hardcore principles) of the theory into question; instead practitioners direct their research towards auxiliary hypotheses. These auxiliary hypotheses can be refuted without implicating the hardcore elements themselves. The refuted auxiliary hypothesis can then be replaced with different auxiliary hypothesis. In effect, they form a protective belt around the central hardcore principles. This is a defensive strategy to make sure that the possible anomalies that could emerge from scientific research are not fatal for the research program. According to Lakatos,

> [I]t should not be thought that yet unexplained anomalies – 'puzzles' as Kuhn might call them – are taken in random order, and the protective belt be built up in an eclectic fashion, without any preconceived order. The order is usually decided in the theoretician's cabinet, independently of the *known* anomalies. Few theoretical scientists engaged in a research programme pay undue attention to 'refutations'. They have long-term research policies which anticipate these refutations. This research policy, or order of research, is set out […] in the *positive heuristic* of the research programme. The negative heuristic specifies the 'hard core' of the programme which is 'irrefutable' by the methodological decisions of its protagonists; the positive heuristic consists of a partially articulated set of suggestions or hints on how to change, develop the 'refutable variants' of the research programme, how to modify, sophisticate, the 'refutable' protective belt. (Lakatos, 1970, p.135)

For Lakatos, the drive toward the self-preservation of a research program that can anticipate the eroding force of potential refutations marks the development of a mature science. In contrast, an immature science is one that proceeds by a mere patch-work of trial-and-error. Mature science anticipates anomalies by employing a mutual interplay of rationalism and dogmatism. He argues that only by considering science as a battle ground of competing research programs rather than isolated theories can we understand 'the rationality of a certain amount of dogmatism' (Lakatos, 1970, p.175). This dogmatism consists in weighing-up the importance of different aspects of a research program and deciding whether these features belong to the positive or negative heuristics of that research program. The hardcore elements or negative heuristics are then protected from potential anomalies by directing research toward auxiliary hypotheses.

The idea that this is a rational part of scientific activity is questionable. The pragmatic reasons for protecting the hardcore elements of a research program are self-evident as the refutation of these principles results in the collapse of the research program, but this does not entail that such protection is rational. The emerging picture of science is that the most fundamental aspects of a research program are protected from empirical and

rational criticism because of the potentially fatal implications for the research program if these principles are shown to be wrong. Instead, enquiry is directed toward the expendable auxiliary hypotheses that can be replaced. In the context of the development of science, such protective measures might be permissible for the development of scientific research programs. For our current purposes, the primary concern is not with the *rationality* or *arationality* of Lakatos' account in the context of the philosophy of science, but the deployment of this conception of research programs to understand Kant's influence on the development of biology.

Lenoir appealed to Lakatos' account to explain Kant's influence on the development of 19th century German biology. According to Lenoir, developmental morphology, cell theory and functional morphology were all indebted to Kant's *Critique of the Power of Judgment*. Kant forms the hardcore element or negative heuristic of the scientific research program that he terms teleomechanism. Lenoir argues that Kant's conception of the morphotype was part of the negative heuristic of the teleomechanist research program. The hard-core elements of a scientific research program 'can never be the object of empirical refutation, and […] cannot be abandoned without repudiation of the program' (Lenoir, 1982, p.13). The teleomechanists were unified by 'an expression of commitment to the holistic conception at the heart of the teleomechanist research tradition' (Lenoir, 1982, p.278).

2. Criticisms of the Lenoir thesis

Lenoir's thesis has generated much controversy. The problem is that Kant's discussion of teleology in the Third *Critique* is not consistent with its application in biology. His account has been the object of criticism because it excludes other figures that were also influential on the development of German biology. Moreover, others have argued that the underlying incompatibility between transcendental idealism and naturalism threatens to invalidate the Lenoir thesis. I argue that both these criticisms expose problems for the account of influence that Lenoir adopts, but do not necessitate the conclusion that Kant did not influence the development of biology. Rather, the conception of influence permitted by the notion of research programs is too restrictive to offer an appropriate understanding of Kant's influence on the development of biology.

Nyhart argues that Lenoir's account does not consider the variety of influences beyond Kant that contributed to the development of German biology. She argues that '[m]ost early nineteenth-century writers on form confound categorisation schemes based on rigid philosophical distinctions; they appropriated the language of Kant, of Schelling, and of Cuvier in different places. […] [M]any had little apparent trouble drawing selectively from […] philosophically opposed systems' (Nyhart, 1995, p.8). The idea that biologists drew selectively from opposed systems is problematic for Lenoir's indebtedness to Lakatos. Lakatos understood that many developments in science have been achieved by means of 'grafting' a new program onto an inconsistent older program. He argues the two programs cannot persist in this symbiotic relationship. According to Lakatos, '[a]s the young grafted programme strengthens, the peaceful co-existence comes to an end, symbiosis becomes competitive and the champions of the new programme try to replace the old programme altogether' (Lakatos, 1970, p.142). Chaos grows within the research program until it is purged of these inconsistencies. 'Grafted' programs serve an important function for emerging research programs as they can exploit their heuristic power over older programs. However, these inconsistencies cannot reside permanently in a research program. 'The reason is simple. If science aims at truth, it must aim at consistency; if it resigns consistency, it resigns truth' (Lakatos, 1970, p.143).

It follows from Nyhart's account that the influences on the development of German biology could not easily be understood as culminating in a single, consistent research program. Lenoir's appeal to research programs as a way of understanding the development of German biology creates an obstacle for appreciating the various figures that these biologists were influenced by. The norms that Lakatos identifies as governing scientific research cannot adequately explain how various influences that are philosophically opposed to one another could have contributed to the development of German biology.

This is related to another issue regarding the broader incompatibility between the principles of transcendental idealism and naturalism. Both Zammito and Richards have criticised the Lenoir thesis on the grounds that it can only establish the connection between Kant and biology by overlooking significant differences between these accounts. They focus on Kant's influence on Blumenbach to expose what they consider to be an underlying insurmountable difference. Lenoir emphasises the mutual support that these philosophers believed their accounts had for one another. In a letter to Blumenbach, Kant

explicitly noted his indebtedness to Blumenbach's essay *On the Formative Impulse*. He recognised the similarity between Blumenbach's conception of formative drive (*Bildungstrieb*) and his attempt to unify teleological and mechanistic explanations of organised nature; 'factual confirmation is exactly what this union of the two principles needs' (C 11:185). Kant was inspired by Blumenbach's view that the emergence of entities that organise their parts and their whole through a special drive could not be explained by appealing to merely mechanical laws. According to Kant,

> [H]e rightly declares it to be contrary to reason that raw matter should originally have formed itself in accordance with mechanical laws, that life should have arisen from the nature of the lifeless, and that matter should have been able to assemble itself into the form of a self-preserving purposiveness by itself. (CJ 5:424)

There is an important difference between the projects of Kant and Blumenbach. Kant explained how our judgments of organisms could not reveal real teleological causes in the objects themselves. Instead we are limited to conceiving of teleological entities—that is, entities that require us to judge them as end directed—as a product of the judgment itself. This distinction means that we are not warranted to assert that our judgments pertaining to biological principles refer to properties of the entity. We judge the entity *as if* the features of the judgment applied to features that are external to that judgment. Therefore, Kant is not offering support to the biological sciences as the biological sciences do not consider the properties specific to organic nature as dependent on our faculty of judgment. Blumenbach proposed that each organism possessed an internal formative force or *Bildungstrieb* that was responsible for its organisation.

> *Bildungstrieb* was thus not a Kantian "as if" cause but a real teleological cause (i.e. one acting for ends), which, albeit, was known only through the ends it achieved. […] Blumenbach clearly spied the Creator unabashedly pulling the strings, a perception no scientific theory in the Kantian mold would legitimate. (Richards, 2002, p.229)

According to transcendental idealism, judging biological entities as governed by teleological principles allowed us to spy nothing more than the act of judging. The transcendental account of organisms is merely a mirror for revealing what is presupposed for teleological judgment, whereas Blumenbach regarded this experience as a window into a realm that Kant argued was beyond the remit of knowledge and was supersensible.

Richards and Zammito are correct to question the consistency of Lenoir's thesis insofar as he does not sufficiently address the implications of Kant's conception of biological phenomena as the product of regulative judgments. The *apparent* similarity

between Kant and Blumenbach hides a deeper difference between their philosophies. However, Lenoir is also aware of this as he recognised that the scientists of the teleomechanist research program transformed Kant's regulative principles into constitutive ones. Lenoir notes, 'Kielmeyer as a biologist found it difficult to remain consistent with this regulative use of the principle. […] [H]e had overstepped the valid limits of the concept of teleology as Kant formulated it.' (Lenoir, 1982, p.53). Lenoir did not consider these biological tendencies to go beyond Kant's regulative principles as destructive for the research program. He clarifies the intentions of his project: 'I do not claim that German biologists discovered the programme of research in Kant's writing which they set out to realize in practice […]. [Kant] set forth a clear synthesis of the principal elements of an emerging consensus among biologists' (Lenoir, 1982, p.2).

Kant's distinction between regulative and constitutive principles is an obstacle to understanding how Kant could form the hard-core elements of the teleomechanist research program. It is not clear in what sense Kant could be regarded as the hardcore element of the research program given the tendency of its members to apply Kant's regulative principles constitutively. Kant's Third *Critique* was attempting to resolve issues that were specific to transcendental idealism. The subsequent biological concerns with the organism were not engaging with the issues that were specific to transcendental idealism. According to Zammito, biology is founded on the principles of naturalism 'and Kant simply cannot be refashioned into a naturalist' (Zammito, 2006, p.749).

This section has demonstrated that Lakatos' conception of research programs is not appropriate for understanding Kant's influence on biology. Lenoir's appeal to Lakatos means he does not consider other possible sources of influence on German biology (as Nyhart argues). He also overlooks the fundamental incompatibilities between transcendental idealism and biology (as Zammito argues). The next section will develop a method of examining influence that reveals that these criticisms do not invalidate claims regarding Kant's influence on biology, rather they only challenge Kant's influence on biology as understood through the conception of research programs.

Lenoir's thesis is a useful resource for understanding the potential difficulties that can emerge when investigating Kant's influence on biology. The method that Lenoir adopts to examine the influence of Kant on the development of biology in 19th century Germany is very different to the method that will be used to examine Kant's influence on

biology in the British Isles.[9] The latter is indebted to the controversies and criticisms that have been raised in relation to the former. This discussion helps us to understand what must be permitted by an account of influence that strives to present Kant's philosophy in a manner that is both philosophically relevant and historically accurate.

4. Influence as misunderstanding

This section considers alternative accounts of influence that do not presuppose that the source of an influence must be compatible with its subsequent effects. I examine Harold Bloom's account of poetic influence which argues that misunderstanding plays an essential role for the development of poetry. Bloom demonstrates how influence can be understood without presupposing the condition of similitude as poets intentionally misrepresent one another through an act of misprision to establish their own poetic identity and novelty. I also examine Paul Feyerabend's philosophy of science that makes a similar claim through his account of the distinction of the context of the discovery of a scientific theory from the context of justification. For Feyerabend, this forms the basis of his argument that the development of science is 'against method'. In contrast, I argue that this account helps to establish a method for understanding how influence can arise out of creative misunderstandings. Finally, I consider how these alternative accounts of influence could offer support to Zammito's claim that the development of biology was caused by a misunderstanding of Kant's philosophy.

The general definition of influence is the capacity to have an effect on the character, development, or behaviour of something or someone. According to Bloom, the etymological connotations of influence have been lost; 'to be influenced meant to receive a divine power; to receive an ethereal fluid […] from the stars' (Bloom, 1997, p.26). The reason why Bloom focuses on the etymology of influence is to demonstrate that historically it lacks clarity and a precise meaning has not been agreed upon. The meaning of 'influence' is something that seems to possess clarity for our common understanding, but when disagreements arise about appropriate sources of influence it is far from clear how these disputes can be resolved.

[9] This will be discussed in chapters 3 and 4.

Bloom's account of poetic influence opposes many of the assumptions that are implicit in the scientific understanding of influence discussed in the previous section. Bloom explains how a poet intentionally misinterprets or creatively corrects their predecessors to establish their own poetic identity. A poet is not limited by the norms of a research program or by scientific training that opposes the emergence of anomalies. In poetry, creative freedom of interpretation can be used as a means of establishing their own legacy. These creative acts are not rational strategies on the part of the poet, rather they are a response to the poet's anxiety about not being remembered. According to Bloom,

> *Poetic Influence – when it involves two strong, authentic poets – always proceeds by a misreading of the prior poet, an act of creative correction that is actually and necessarily a misinterpretation. The history of fruitful poetic influence, which is to say the main tradition of Western poetry since the Renaissance, is a history of anxiety and self-saving caricature, of distortion, of perverse, wilful revisionism, without which modern poetry as such could not exist.* (Bloom, 1997, p.30)

Bloom argues that the history of poetry cannot be separated from this account of poetic influence. The history of poetry can only be understood by identifying how poets have misunderstood one another. He explains his examination of the history of the trajectory of poetic influence by appealing to Lucretius' notion of clinamen. This refers to the unpredictable and spontaneous free movement (or swerve) of atoms in a void which was central to the philosophy of Democritus. He argued that the cosmos consisted of atoms falling in an infinite void so that the production of objects must have been the result of one atom spontaneously swerving into another. Poets also manifest these spontaneous 'swerves' through acts of misrepresentation (creative correction or misprision) that are the cause of them diverging from their precursors. According to Bloom, 'the true history of modern poetry would be the accurate recording of these revisionary swerves' (Bloom, 1997, p.44). Bloom's account of influence helps us understand how influence does not necessarily depend on similitude. There is no requirement for the source of influence to be consistent with its effects.

The philosopher of science, Paul Feyerabend, has also argued that new scientific theories can develop by irrational or *arational* means. He utilises the distinction between the context of discovery and the context of justification: '*[d]iscovery* may be irrational and need not follow any recognized method. *Justification*, on the other hand […] starts only *after* the discoveries have been made, and it proceeds in an orderly way'

(Feyerabend, 1978, p.165). This distinction was originally formulated by Reichenbach to separate the contextual factors that determine the validity of a theory from the factors that are specific to its conception. The former relates to the context of justification whereas the latter relates to the context of discovery. Reichenbach explains the difference between these contexts with the example of being faced with a mathematical problem:

> If any solution is presented to us, we may decide unambiguously and with the use of deductive operations alone whether or not it is correct. The way in which we find the solution, however, remains to a great extent in the unexplored darkness of productive thought and may be influenced by aesthetic considerations, or a "feeling of geometrical harmony." (Reichenbach, 1938, p.384)

For Reichenbach, the context of discovery relates to those aspects of a theory that cannot be subject to critical examination. Thus, Reichenbach distinguishes between the contexts of justification and discovery on the basis that the former refers to the critical aspects of a theory whereas the latter is descriptive. Popper compared this aspect of Reichenbach's account with Kant's distinction between questions of fact and questions of justification. Aspects of a theory belonging to the context of discovery can only be explained factually or descriptively. Popper rejects the relevance of these aspects of a scientific theory for the analysis of scientific knowledge. According to Popper, '[t]he question of how it happens that a new idea occurs to man […] may be of great interest to empirical psychology; but it is irrelevant to the logical analysis of scientific knowledge' (Popper, 1980, p.31). Reichenbach does not completely reject the importance of the context of discovery for scientific knowledge as many aspects of a scientific theory fall within this domain. For instance, he argues that conventional aspects of a theory such as units of measurement belong to the context of discovery and these features constitute 'an integral part of the critical task of epistemology' (Reichenbach, 1938, p.9).

The difference between Feyerabend's and Reichenbach's distinctions of the contexts of discovery and justification is that the former argues these are temporally distinct moments in the development of a theory. The context of the discovery of a science and its subsequent justification are different stages with different conceptual requirements. These conceptual requirements are not merely different from one another, they are in *conflict* with one another. Hence the discovery or invention of a new science is not restricted to the methodological rules by which that science is subsequently justified. The notion that the discovery of a scientific theory is not a rational process allows us to expand the scope of the sources of potential influence. Influence is only

limited by the creative imagination of the individual and the source of inspiration for a scientific theory, it does not have to be compatible with that scientific theory. It is only important the scientist does not recognise that these sources of influence cannot be sufficiently justified.

Feyerabend does not consider the possibility that aspects of the discovery of a theory might, in principle, be unjustifiable. However, this was the motivation for the criticism of the Lenoir thesis. Recall that for Lenoir, Kant constituted the hardcore principles of the research program of teleomechanism. It followed that research is directed away from the hardcore principles toward auxiliary hypotheses. Lakatos described these auxiliary hypotheses as forming a protective belt around the hardcore principles of the research program. The possible inconsistences of the hardcore principles within the scientific research program are protected from exposure by the mechanisms that direct research toward auxiliary hypotheses. According to Feyerabend,

> It is clear that allegiance to new ideas will have to be brought about by means other than arguments. It will have to be brought about *by irrational means* […]. We need these irrational means in order to uphold what is nothing but a blind faith until we have found the auxiliary sciences, the facts, the arguments that turn faith into sound 'knowledge'. (Feyerabend, 1978, pp.153-4)

The reason that Feyerabend argued that his account of the philosophy of science was '*against method*' is also the basis for developing his account into a method for understanding influence. His account of the source of influence as irrational allows us to consider Kant's influence on the development of biology from a different perspective.[10] In relation to Lenoir's account, it provides the basis for understanding Kant's influence on 19th century German biology without presupposing Kant's compatibility with biology. According to Kant's critical philosophy, the possibility of experiencing organisms is dependent on our capacity to judge entities in accordance with final causes. In contrast, biologists tend to regard the features of organisms that Kant relegates to judgment as capacities of the organism independent of judgment. This difference led Zammito to conclude that transcendental idealism is irrelevant and useless for contemporary philosophy of biology. According to Zammito, '[i]f biology must conceptualize self-organization as actual in the world, Kant's regulative/constitutive distinction is pointless

[10]This perspective has no difficulty understanding how Kant was inspired by the biological account of epigenesis to develop the position that the emergence of reason was epigenetic. This was not compatible with the biological account of epigenesis, yet it was still influential on the development of transcendental idealism.

in practice and the (naturalist) philosophy of biology has urgent work to undertake for which Kant turns out not to be very helpful' (Zammito, 2006, p.766). Approaching this issue from a historical perspective allows us to appreciate the importance of Zammito's criticism, but simultaneously recognise that many biologists have appealed to aspects of Kant's philosophy that are not compatible with naturalism. Kant's influence on biology was only possible because biologists misunderstood the principles of transcendental idealism and used them as support for their research and theories. Feyerabend's account of the context of discovery allows us to appreciate Kant's influence without imposing that this influence must be sufficiently justified in accordance with transcendental idealism.

This approach helps makes sense of an inconsistency within Zammito's account. Zammito is incorrect to infer that Kant could not have been influential on the development of biology because of the incompatibility between transcendental idealism and naturalism. He concedes that Kant was an essential influence on the development of biology; '[o]nly by misunderstanding Kant did biology as a special science emerge at the close of the eighteenth century' (Zammito, 2006, p.765).[11] Zammito is attempting to reduce Kant's influence on biology to a mere misunderstanding to demonstrate his insignificance. However, it also implicitly identifies how this misunderstanding was essential for the development of biology. Hence, the tension within Zammito's account is that Kant was both causally responsible for the development of biology and that the original formulation of Kant's philosophy has little to offer biology. This tension is resolved if influence is separated from the condition of similitude. The account I have presented is not opposed to Zammito insofar as any aspects of naturalist philosophies that have appealed to transcendental idealism may not be able to establish appropriate justification for these principles in accordance with their naturalism. They would not be able to find appropriate justification because of the incompatibility between transcendental idealism and naturalism. This doesn't demonstrate an absence of influence, but rather exposes the need to re-examine these aspects of their theories that appealed to Kant's critical philosophy and understand why these issues could not be resolved through naturalism alone.

[11] Analogously, on the relation between Kant and Blumenbach, Zammito asserts 'Blumenbach's affiliation with Kant is best understood as a misunderstanding. But it was a creative misunderstanding, because it enabled Blumenbach and his followers to continue with even greater energy the development of that new science' (Zammito, 2012, p.127)

Conclusion

The account of influence developed in this section demonstrates how transcendental idealism could have influenced the development of biology, despite its incompatibility with naturalism. Kant was misunderstood by these biologists who appealed to his philosophy as supporting their account of biology. These misunderstandings were important for the development of biology because it allowed them to resolve problems or stimulate research based on principles that went beyond the limits of what could be justified in accordance with naturalism. This serves as justification to re-address the Kantian legacy of biology because biologists need to address the aspects of their theory that were made possible by this misunderstanding.

The chapter began with a brief discussion of Strawson's interpretation of Kant. I argued that his interpretation overlooked important historical and philosophical aspects of Kant's philosophy because he approached Kant from the perspective of the 'scientifically minded philosopher'. I also considered how accounts of the methodologies of history and science have developed over time. Berlin argued that historical method could not achieve the certainty of scientific method. The former depends on the sagacity of individual historians whereas scientists follow logical procedures that are directed toward a unified conception of science. In contrast, Kuhn considered the development of science from a historical perspective to show how this development has been constituted by revolutions or 'paradigm shifts'. The presentation of science as uncovering a single unified explanation is a pedagogical mechanism that covers up the context of its revolutionary emergence. Lakatos amended certain aspects of Kuhn's account; specifically, he argued that scientific method can anticipate the potential impact of future anomalies and direct research toward aspects of a theory that, if proven wrong, will not bring the entire research program into question. Lakatos referred to this as the positive and negative heuristics of a research program.

Lakatos' conception of research programs was instrumental for Lenoir's examination of Kant's influence on the development of 19th century German biology. According to Lenoir, Kant formed the hardcore elements or negative heuristics of the research program of teleomechanism. I examined criticisms of Lenoir's account and argued these were directed against his adoption of Lakatos' conception of influence,

rather than against Kant's influence on the development of biology. Alternative explanations of influence were examined which allowed for the possibility that Kant influenced the development of biology without presupposing that Kant's original formulation was compatible with its subsequent use. Bloom's account of poetic influence suggested that poets form their own poetic identity through acts of misprision. In contrast, Feyerabend utilised the distinction between the contexts of justification and discovery to show how many scientific theories originate from irrational principles. This reveals that Kant could have influenced the development of 19th century German biology, despite the incompatibility between transcendental idealism and naturalism.

Chapter Two: Kant's response to Hume and the status of laws in contemporary philosophy of science

Introduction

This chapter examines Hume's influence on the development of Kant's critical philosophy. This focus on Hume's influence helps us to understand why Kant considered transcendental idealism as a necessary response to the philosophical issues of his time. By examining the aspects of Hume's philosophy that motivated the development of transcendental idealism, it is possible to separate the reasons for the emergence of transcendental idealism from the solutions that transcendental idealism offered to these problems. This introduces some relevant aspects of Kant's critical philosophy that are important for critically examining Kant's influence on the development of biology in the British Isles in the 19th century.

Hume's influence on Kant is examined from both historical and philosophical perspectives. In this sense, it is continuing the approach adopted in the previous chapter. This makes it possible to assess the accuracy of Kant's interpretation of Hume and examine the potential reasons for any misunderstandings. Crucially, Kant's interpretation misunderstood Hume's distinction between relations of ideas and matters of fact as he regarded relations of ideas as logical truths that required no experience. In contrast, Hume argued relations of ideas were psychological truths that required experience. This hid a deep similarity between Hume's relations of ideas and Kant's conception of the synthetic *a priori*. Kant thought transcendental idealism was responding to the shortcomings of Hume's empiricism. For Kant, transcendental idealism enabled the move beyond Humean scepticism regarding the impossibility of providing any rational justification for our belief in causality. Kant famously asserted that his remembrance (*Erinnerung*)[12] of Hume awoke him from his dogmatic slumber (P 4:260). Transcendental idealism was not merely a response to Hume; Kant regarded it as a continuation of the project started by his predecessor. The *Critique of Pure Reason* was 'the *elaboration* of the Humean problem in its greatest possible amplification' (P 4:261). This presents the incompatibility between

[12] This term can also be translated as memory, recollection, reminder or reminiscence.

Humean naturalism and transcendental idealism not as an impasse, but rather as a transition from the former to the latter.

The first section examines Kant's interpretation of Hume. It begins by briefly outlining the sources that were available to Kant and the implications that this restricted access had for his interpretation. I endorse Watkins approach toward Hume that suggests that Kant is not attempting to offer a refutation of Hume's philosophy on his own terms, but rather aims to develop transcendental idealism from the foundations of Hume's philosophy. Following this I argue that Kant misunderstood Hume's distinction between matters of facts and relations of ideas. Kant interpreted Hume as arguing that relations of ideas were analytic and therefore logical truths that were true independent of experience. Hume justified relations of ideas as psychological certainties, rather than logical ones. Relations of ideas require empirical justification, but this kind of justification is fundamentally different to the justification of causal regularity derived from matters of fact, which is habitual. This misunderstanding resulted in Kant overlooking the similarity between his account of synthetic *a priori* propositions and Hume's relations of ideas as both were directed toward establishing necessity from experience.

The second section contrasts Kant's interpretation of Hume with the sceptical realist interpretation. The sceptical realist interpretation argues that whilst Hume was an epistemological antirealist, he was nonetheless committed to an ontological realist position regarding necessary causal laws. Aspects of the sceptical realist interpretation present Hume in a manner that more closely resembles Kant's position. I explain how Kant regarded Hume's scepticism as part of the transition of the history of philosophy from dogmatic metaphysics toward the realisation of a critical philosophy. Transcendental idealism develops an alternative explanation to Hume's argument regarding the impossibility of providing a rational justification for the belief in necessary causal connections between things in themselves. Kant thought Hume was entirely correct in his assessment, but that the way to re-establish the importance of reason was by separating objects in themselves from experiences of objects and arguing that causal necessity could only be established in relation to the latter. I also briefly examine the tension between the two-world and two-aspect interpretations of Kant's philosophy in the context of the discussion of Hume's influence on Kant. These interpretations differ in their treatments of the relation between things in themselves and appearances. Proponents of the former argue that phenomenal and noumenal entities belong to two different worlds

whereas the latter assert that these are merely two aspects of the same entity. I consider the implications that this has for Kant's conception of the relation between theoretical and practical philosophy.

The final section discusses accounts of the metaphysical status of laws in contemporary philosophy of science. I compare Bhaskar's critical realism with Cartwright's nomological pluralism. Bhaskar argues that the possibility of science requires that necessary universal laws exist. These laws are *intransitive*, whereas science can only investigate the *transitive* manifestations of these laws at the empirical level. In contrast, Cartwright argues that there is little empirical evidence to believe in the existence of *intransitive* laws and instead we should direct scientific research toward the regularities that we can establish at the local level through scientific experiment. This supports the idea that causal regularities must be understood in the contexts specific to its manifestation, rather than demonstrating the existence of universal laws. I consider how both Cartwright and Bhaskar appeal to transcendental arguments to justify their philosophies of science and argue that neither of these would be permitted by Kant's critical philosophy.

1. Kant's interpretation of Hume

This section examines Hume's influence on Kant. First, it offers a brief examination of the sources that might have contributed to Kant's interpretation of Hume. In contrast to many interpretations that focus primarily on Kant's treatment of Humean causality, I consider Kant's more general interpretation of Hume's distinction between matters of facts and relations of ideas. Kant misunderstood this aspect of Hume's philosophy by regarding it as a logical distinction between analytic relations of ideas on the one side, and synthetic matters of fact on the other. This is a continuation of the conception of influence developed in the previous chapter where I demonstrated the importance of Kant's influence on biology despite the potential incompatibility between Kant's critical philosophy and biological naturalism. In this context, I argue that Kant's misunderstanding of Hume was significantly influential for the subsequent development of transcendental idealism.

1. The sources of Kant's interpretation of Hume

Kant's interpretation of Hume is best approached by considering the sources that Kant derived his interpretation from. Kant was most familiar with Hume's *Enquiry Concerning Human Understanding* as it was translated into German in 1755. A complete translation of Hume's *Treatise of Human Nature* (translated by Ludwig Heinrich Jacob) was not produced until 1792.[13] This means that, to the best of our knowledge, Kant could not have been aware of the complete content of this work until after the publication of the Third *Critique*.

The inaccessibility of the *Treatise* has been regarded as a contributing factor in Kant's inaccurate representation of Hume's account of causality. For instance, Beck argued that Kant drew heavily from Beattie's commentary on Hume's *Treatise*.[14] This commentary possibly misled Kant to believe that the *Treatise* contained a more substantial treatment of causality than it did. He suggests that if Beattie had not misrepresented the *Treatise,* then Kant might not have been motivated to develop his account of transcendental idealism. Hence, Beck describes this as 'a fortunate historical error' (Beck, 1978, p.120). According to Beck, Beattie's explanation

> may have misled Kant into thinking that there was an argument to which he needed to reply, not just an "opinion". There is no such argument, and Hume's implicit account of the causal principle is more like Kant's own than Kant had any reason to suspect. (ibid)

Both Kant's dependence on Beattie's interpretation and the inaccuracy of Beattie's account have been disputed. Guyer suggests that the content of Beattie's analysis of Hume would not have significantly added to Kant's interpretation (Guyer, 2008, p.76fn). Moreover, Kuehn has argued that Beattie presents an accurate account of Hume's causality (Kuehn, 1983, p.189). These reservations concerning the inaccuracy and significance of Beck's analysis of Hume suggests that the factors that contributed to Kant's interpretation are found elsewhere.[15]

Scholarship discussing Hume's influence on Kant has generally focused on Kant's treatment of Hume's account of causality. In opposition to this view, Watkins has argued

[13] The last chapter of Book one of the *Treatise* was translated for the *Königsberger Zeitung* in July, 1771 (Kuehn, 1983, p.185).
[14] Beattie's *Essays on the Nature and Immutability of Truth* was translated into German in 1772.
[15] To be clear, this does not mean that Beattie's account had no influence on Kant; rather Kant's interpretation was the result of Beattie, Hume's *Enquiry* and his limited access to the *Treatise* (Cf. Kuehn, 1983).

that Kant cannot be regarded as attempting to refute Hume's account of causality because the differences between their philosophies are so vast that they 'share no neutral philosophical vocabulary that would allow Kant to formulate a refutation of Hume on Hume's own terms' (Watkins, 2005, p.386). For Kant to be offering a refutation of Hume, there would need to be shared principles between their theories that were translatable from one theory to the other. Watkins account has been criticised on the grounds that the criterion he adopts for refutation are far too narrow (Guyer, 2008, p.20) and would exclude most philosophical refutations except those that reveal an inconsistency in an opponent's position (Allison, 2008, p.356, fn.1). Whilst Watkins' account of refutation is potentially too restrictive, he convincingly illustrates how Kant's treatment of Hume should not be regarded as an immanent refutation aimed at demonstrating Hume's falsehood on his own terms. This does not entail that Hume was not influential for Kant, but rather that transcendental idealism should be regarded more broadly as developing from, rather than responding to, Hume's philosophy. Kant appeals to Hume's philosophy to reveal the need for transcendental idealism to overcome the limitations of Hume's approach.

2. Kant's misunderstanding of Hume's relations of ideas and matters of fact

Kant's discussions of Hume in the First and Second *Critiques* and the *Prolegomena* indicate that Kant regarded Hume's treatment of relations of ideas as the primary obstacle to the completion of Hume's own sceptical method; moreover, Kant regarded his philosophy as correcting this oversight. I argue that Kant's misunderstanding of Hume's conception of relations of ideas meant that Kant did not recognise the similarity between this aspect of Hume's philosophy and his own development of the synthetic *a priori*.

According to Kant, Hume's scepticism was only directed at the relation between matters of facts and metaphysics (cf. CPR A761/B788). The metaphysical principle that Hume directed his scepticism toward was causality as he asserted that '[a]ll reasonings concerning matters of fact seem to be founded on the relation of *Cause and Effect*' (E 22). This scepticism drew attention to our lack of warrant for establishing deductive knowledge of future events from the occurrence of past events. Hume argued that it was impossible to produce any rational argument which proves that future events will resemble past events. The statement "the sun will not rise tomorrow" is no less intelligible

or contradictory than its alternative. It is no less intelligible because it is impossible to offer any rational justification for the belief that one event follows another with causal necessity. According to Hume, 'when we reason *a priori*, and consider merely any object or cause […] it never could suggest to us the notion of any distinct object, such as its effect; much less, show us the inseparable and inviolable connection between them' (E 26).

It is helpful to consider Kant's distinction between the justification (*quid juris*) for the concepts that we employ and the fact (*quid facti*) that we do use these concepts (CPR A84/B116). Hume is not arguing that we do not use the concept of causality (*quid facti*); rather, he is arguing that we are not rationally warranted in our use of this concept (*quid juris*). Hume explains that our belief in causality is derived from custom or habit. Custom allows us to infer that one event will follow another without presuming to have offered rational justification for this propensity. According to Hume,

> wherever the repetition of any particular act or operation produces a propensity to renew the same act or operation, without being impelled by any reasoning or process of the understanding, we always say, that this propensity is the effect of *Custom*. By employing that word, we pretend not to have given the ultimate reason of such a propensity. (E 36)

Kant regarded Hume as having performed a service to philosophy by demonstrating that causal necessity could not be justified metaphysically (cf. PM 20:266). However, Kant argued, Hume did not extend his scepticism far enough because of his distinction between relations of ideas and matters of fact. Kant understood Hume's relations of ideas as logical truths which are known independently from experience. Hume apparently relegated mathematics to a pure analytic discipline devoid of any input from experience. Kant regarded himself as developing Hume's philosophy because he thought that Hume had protected mathematics from scepticism. According to Kant, it was as if Hume said that '[p]ure mathematics contains only analytic propositions, but metaphysics contains synthetic propositions *a priori*' (P 4:272). Kant does not mean that Hume thought that metaphysics contained synthetic *a priori* propositions in the sense of establishing transcendental necessary conditions for the possibility of experience. Rather, he thought that Hume's criticism of the claim to derive necessary causal relations from our inductive experience of objects revealed the impossibility of establishing *a priori* knowledge about objects independent of experience. For Hume, any *a priori* justification for metaphysical principles such as causality was inconceivable. Hume proclaimed such principles were

nothing but sophistry and illusion and should be committed to the flames (E 131). Kant wholeheartedly supported Hume's criticism of metaphysics based on the presuppositions of Hume's philosophy. According to Kant, 'when Hume took the objects of experience as things in themselves (as is almost always done), he was entirely correct in declaring the concept of cause to be deceptive and an illusion' (CPrR 5:53). This supports Watkins claim that Kant could not be offering a refutation of Hume on his own terms, at least in relation to Hume's account of causality. Kant agreed with Hume's criticism on the condition that it was directed toward things in themselves.

The essential limitation of Hume's philosophy was that he did not question whether our experience of objects was directly related to objects as they are in themselves. Hume appealed to the power of habit to explain the relationship between appearances and things in themselves. According to Hume, 'without any reasoning […] we always suppose an external universe, which depends not on our perception, but would exist, though we and every sensible creature were absent or annihilated' (E 118). This reinforces the opposition between reason and habit within Hume's philosophy. Any appeal to certainty regarding both the objects independent of experience or the necessary causal connections between these objects is habitual. Reason must remain silent on such issues as '[t]he mind has never anything present to it but the perceptions, and cannot possibly reach any experience of their connexion with objects. The supposition of such a connexion is, therefore, without any foundation in reasoning' (E 119). Philosophy is embarrassed by its inability to either refute or justify this appeal to instinct. Philosophy cannot 'plead the infallible and irresistible instincts of nature: for that led us to quite a different system […]. And to justify this pretended philosophical system […] exceeds the power of all human capacity' (ibid).

Kant intended to show how philosophy could overcome this embarrassment by reorienting our enquiry toward how the objects of experience are inseparable from the human faculties of sensibility, understanding and reason. The ambitious aim of transcendental idealism was to dispel any appeal to ignorance. Kant argued that experience must be understood in relation to the faculties that are necessary for the possibility of experience. This made it possible to reject the appeal to rational ignorance regarding the human propensity toward the belief of causal necessity that was derived from habit. If we correctly understand how the limits of knowledge can be appropriately demarcated in relation to these faculties, then we can explain why we are unable to answer

certain questions because they transcend the limits of possible knowledge. Kant does not appeal to habit to explain the regularity between the appearance of objects and objects as they are in themselves, rather he argues that the appearance of the object could not relate to the thing in itself. According to Kant,

> The strictest idealist cannot demand that one prove the object outside us […] corresponds to our own perception. For if there were such a thing, then it still could not be represented and intuited outside us […]. The real outer is thus actual only in perception, and cannot be actual in any other way. (CPR A375)

The similarity between Kant and Hume is striking, yet Kant argues that the inability of reason to justify the relation between appearances and things in themselves does not show the deficiency of reason in relation to habit, but rather shows the illegitimacy of the extension of habit on these matters. For any speculative matter that transcends possible experience 'the very same concept that puts us in a position to ask the question must also make us competent to answer it' (CPR A477/B505).[16] In this sense, Kant's philosophy was aiming to extend the principles of Hume's philosophy and transform it into a systematic account of knowledge. In contrast, Hume approached philosophy merely as an academic exercise; he described how reason led him to 'philosophical melancholy and delirium' that was remedied by engaging in social activity. According to Hume, 'after three or four hour's amusement, I wou'd return to these speculations, they appear so cold, strain'd, and ridiculous, I cannot find it in my heart to enter into them any further' (T p.269).[17] Kant's extension of Hume demonstrated that these were not merely academic concerns. According to Guyer, 'Kant does not refute Hume's academic worry about induction, but rather replaces it with a substantive theory of the imperfection of our knowledge of natural law' (Guyer, 2017, p.67).

Kant regarded Hume as coming closest to discovering the possibility of synthetic *a priori* truths (CPR B19). In this context, he is referring to the use of synthetic *a priori* statements as necessary conditions for the possibility of experience, rather than exposing the illegitimate way that they were used to establish metaphysical arguments previously mentioned. For Kant, Hume did not realise the difference between the conditions of objects of appearance and objects in themselves because of his treatment of mathematics. He argued that Hume protected mathematics from his scepticism by regarding it as

[16] Also (cf. CPR 763/791).
[17] We can assume that Kant would have read this passage as it is from the chapter of the *Treatise* that was published in German in 1771.

analytically and logically true; belonging to relations of ideas. According to Kant, if Hume had not done this,

> he would have to accept that mathematics is synthetic as well. But then he would by no means have been able to found his metaphysical propositions on mere experience, for otherwise he would have to subject the axioms of pure mathematics to experience as well, which he was much too reasonable to do. (P 4:273)

This is both an insight into Kant's interpretation of Hume and a significant source of motivation for transcendental idealism. Kant's intention for transcendental idealism was to preserve Hume's scepticism against traditional or dogmatic metaphysics whilst simultaneously establishing an alternative ground for certainty in relation to the necessary conditions for the possibility of experience. Kant regarded Hume's scepticism as potentially more far reaching than Hume had apparently considered; 'Hume's empiricism leads inevitably to scepticism even in respect to mathematics and consequently in the entire theoretical scientific employment of reason' (CPrR 5:52).

Kant thought that if Hume had realised the implications of his scepticism for mathematics, then this would potentially have led Hume to reorient his account of causal necessity toward the discovery of a synthetic *a priori* ground in relation to appearances. Hume would have realised that mathematics also required a ground rather than assuming it was logically certain. The only way that Hume could have avoided mathematics becoming susceptible to the scepticism that he had deployed to great effect against the rational justification for causal necessity would be to distinguish the conditions of knowledge of appearance from the conditions of knowledge of objects in themselves. This would have enabled Hume to simultaneously establish the certainty of mathematics and uphold his scepticism toward causal necessity pertaining to objects in themselves. However, if Hume had realised that mathematical knowledge could secure certainty in relation to experience, he might have realised how knowledge of causal necessity could also be established in relation to appearances. These steps were precisely how Kant transformed the problem of induction that Hume had exposed into the foundations for the system of transcendental idealism.

The problem with Kant's account of Hume is that it is based on a misunderstanding of Hume's conception of relations of ideas. *Pace* Kant, in both the *Enquiry* and the *Treatise* Hume did not regard mathematics as analytic in the sense that it was justifiable independent of its empirical demonstration. Kant misunderstood Hume's

distinction between analytic and synthetic justifications because he assumed it was a logical distinction, whereas Hume regarded it as a psychological distinction. To consider something as contradictory in the sense that it is psychologically unimaginable does not entail that it is logically impossible. Logical necessity is independent of demonstration, whereas psychological necessity requires demonstration. Gotterbarn argues that both establish the same degree of certainty: '[t]o claim that the certainty appropriate for these relations is psychological rather than logical has no effect on the degree of certitude appropriate to these relations' (Gottenbarn, 1974, p.279).

Beck suggests the source of this misunderstanding was that Kant had not read the *Treatise*.[18] If he had, then 'he would have found Hume tacitly admitting a class of intuitively and demonstratively necessary relations of ideas which are not testable by the logical law of contradiction' (Beck, 1978, p.84). *Pace* Beck, this distinction is also evident in the *Enquiry* as Hume 'criticizes argumentation by mere definition as "sophistry" and contrasts such arguments with mathematical and demonstrative reasoning' (Gottenbarn, 1974, pp.280-1). Mathematics differs from sophistic arguments because it depends on demonstration and enquiry. Hume considers the following example of a sophistic argument: '*that where there is no property, there can be no injustice*, it is only necessary to define the terms, and explain injustice to be a violation of this property' (E 131). In this case, the demonstration of the correctness of the statement merely depends on defining terms in a circular way. In contrast, mathematics and geometry are verified through experience. They are not matters of fact because our knowledge of mathematical and geometric laws is not derived from repetition and habit. In summary, if the distinction between matters of fact and relations of ideas were a logical distinction, then it would not be possible to explain Hume's further distinction between relations of ideas and sophistic arguments.

This reveals a close similarity between Hume's account of relations of ideas and Kant's account of synthetic *a priori* judgments. Both transcendental idealism and Humean empiricism were concerned with the possibility of establishing *a priori* certainty which is derived synthetically (Gottenbarn, 1974, p.281). Relations of ideas demonstrate their *a priori* necessity because it is psychologically inconceivable that they could be

[18] The translations of both the *Prolegomena* (4:273) and the *First Critique* (B19) are accompanied by editor's notes that comment on the difference between Hume's account in the *Treatise* and *Enquiry*. They suggest that Kant had not read the *Treatise* when he produced these texts, yet they maintain that Kant's account is consistent with the *Enquiry*.

otherwise. It is a process of reasoning by which the synthetic demonstration of a proof, axiom or theory entails its certainty. These proofs are not grounded in the repetition of events that are experienced as regularities derived from habit or custom. The certainty of this kind of knowledge is derived from the 'operations of thought'. This is strikingly similar to Kant's conception of synthetic *a priori* judgments.[19]

This section has examined the sources that contributed to Kant's interpretation of Hume's philosophy and indicated how Kant's misunderstanding of Hume's distinction between relations of ideas and matters of fact was instrumental for the development of Kant's critical philosophy. I have argued that Hume did not protect mathematics from his scepticism in the sense that he merely assumed that mathematics was immune to the problems identified for matters of facts. Like Kant, Hume thought that mathematics was justified in accordance with synthetic experience that demonstrated its *a priori* certainty. Despite the underlying similarity between Hume's conception of mathematics and Kant's account of the synthetic *a priori*, this did not cause Hume to reassess his entire philosophy as Kant had suggested it would.

2. Interpretations of Hume's philosophy

This section compares Kant's interpretation of Hume with the sceptical realist interpretation. The sceptical realist interpretation of Hume argues that he was only sceptical of laws at the epistemological level, but he nevertheless believed in the ontological existence of laws. It examines how this interpretation is supported by Hume's appeal to pre-established harmony. Pre-established harmony was originally formulated by Leibniz who argued that there was no direct causal relation between the laws of the mind and the laws of nature. Hume's appeal to pre-established harmony stands in tension with his empirical scepticism. This serves as a basis both for understanding Hume's influence on Kant and identifying the points of divergence between their philosophies. Sceptical realism develops from the ambiguity of Hume's appeal to laws independent of

[19]In this sense, Kant was incorrect to regard himself as the first person to identify the distinction between synthetic and analytic judgments; moreover, his claim that some experiences were dependent on *a priori* foundations was also not completely original. According to Gottenbarn 'Many philosophers before Kant had made synthetic judgements known a priori; such judgements were not the invention of Kant' (1974, p.281).

experience whereas transcendental idealism demonstrates why knowledge of such laws is impossible. Finally, Hume's broader influence on Kant's distinction between the theoretical and practical uses of reason is examined in relation to the two-world and two-aspect interpretations of Kant.

1. The sceptical realist interpretation of Hume

Kant's interpretation of Hume must be distinguished from the sceptical realist interpretation of Hume which suggests that Hume was an ontological realist about the existence of causal powers and external objects. This realism is sceptical because, despite positing the existence of causal powers and external objects, it is also claimed that we can know nothing about them because of our epistemic limitations. Galen Strawson argues that Hume was merely an epistemological—not an ontological—antirealist about causal laws. According to Strawson, the ontological antirealist interpretation of Hume conflates Hume's epistemological claim that '[a]ll we can ever know of causation is regular succession' with the ontological claim '[a]ll that causation actually is, in the objects, is regular succession' (Strawson, 2008, p.418). Strawson appeals to various references that Hume makes to the secret springs and principles of nature in support of Hume's belief that such entities existed. Hume merely intended to show that we could not justify these principles from an epistemological standpoint. According to Richman, '[a] sceptical realist about some entity is realist about the entity's existence, but agnostic about the nature or character of that thing because it is epistemically inaccessible to us in some non-trivial way' (Richman, 2000, p.1)

Hume describes the correspondence between custom and nature as 'a kind of pre-established harmony between the course of nature and the succession of our ideas' (E 44). This supports the sceptical realist interpretation insofar as it demonstrates Hume's belief in the existence of the external world. Hume's appeal to pre-established harmony is generally regarded as an implicit appeal to Leibniz. Pre-established harmony is Leibniz's solution to the problem of the causal interaction between the mind (or soul) and the body. For Leibniz, there is no causal interaction between these substances. Their apparent reciprocal causal influence is explained in terms of their pre-established harmony maintained by God. The soul and body are in conformity with each other as '[t]he soul follows its own laws and the body also follows its own; and they agree in virtue of the harmony pre-established between all substances, since they are all representations of a

single universe' (Leibniz, 1989, p.223). Hume's appeal to pre-established harmony is in tension with his scepticism as it is beyond empirical justification. According to Guyer, this appeal is sincere and demonstrates Hume's deviation from 'true scepticism' in the *Enquiry*. In contrast, Floyd argues this passage is 'drenched with characteristic Humean irony' (Floyd, 2003, p.37). If Hume's statement is meant ironically, then the question of the correspondence between custom and nature remains unanswered. The sincerity of Hume's commitment to pre-established harmony is less important than the underlying problem. That is, Hume appealed to pre-established harmony because there was not a more suitable explanation for the correspondence of our ideas with the powers of nature. According to Hume, nature has 'implanted in us an instinct, which carries forward the thought in a correspondent course to that which she has established among external objects; though we are ignorant of those powers and forces, on which this regular course and succession of objects totally depends' (E 45). The habitual or instinctual belief in causality is so powerful that we cannot seriously doubt or suspend it. For Hume, there is no rational basis for explaining the conformity of objects in nature with custom or habit. This presents Hume's scepticism in a very different manner as it is merely directed at the inability to provide any rational justification for pre-established harmony, even though we believe in the existence of objects independent of experience and their necessary causal relations based on habit or custom. According to Guyer,

> He [Hume] certainly does not argue that we should suspend our belief in causality, as a genuine sceptic might; on the contrary […] he claims that "no reasoning or process of the thought and understanding" is capable of preventing the operation of our natural instincts to form causal beliefs. (Guyer, 2008, p.89)

Guyer argues that Kant's awakening from his dogmatic slumber might not have been caused by Hume's scepticism but rather his dogmatism, that is, his 'assumption of the good fit between our faculties and the world around us' (Guyer, 2008, p.93).[20] In opposition to Guyer, the sceptical realist interpretation argues that it is Hume's belief in the good fit of our faculties with real powers that results in Hume's avoidance of dogmatism. The sceptical realist opposes any interpretation of Hume that 'dogmatically denies the existence of real powers, or dogmatically affirms that causation is nothing but constant conjunction' (Winkler, 2000, p.67). In attempting to avoid the charge of

[20] This also provides an explanation for why Hume did not consider mathematics to be susceptible to the problem of causality. Mathematics was derived solely from our rational operations of thought, whereas causality could not be explained rationally but was merely a product of habit.

dogmatism, the sceptical realist posits the existence of entities that we cannot have knowledge of. This directs the sceptical realist toward a different form of dogmatism.

For Strawson, Hume's appeal to pre-established harmony makes it possible for Hume to establish a connection between causal connections at the epistemological and ontological levels. According to Strawson, 'the Imagination works the merely regular-succession notion of causality in the objects into a truer notion of causation in the objects, a notion of Causation' (Strawson, 2014, p.228).[21] Strawson explains that Hume could not present his account in these terms because of his empiricism toward conceptual content. He argues that Hume's account entails a more modest version of this argument. According to Strawson, Hume 'can, certainly, say that it's part of the wisdom of nature to make us rely implicitly on inductive procedures, and reason about matters as if we knew that the world was governed by necessary causal laws' (Strawson, 2014, p.228-9). For Strawson, Hume's appeal to the wisdom of nature amounts to our innate capacity to deploy concepts which could be the product of God or evolution.

There are two problems with Strawson's account. First, even if Hume did regard the wisdom of nature as something like the product of evolution or God, this would not explain why we are warranted to comprehend nature as if it were governed by necessary causal laws. It would merely show that we do comprehend nature as such. Second, Strawson's explanation of Hume's modest claim is strikingly similar to Kant's account of nature as ordered by regulative principles that are projected onto nature by the subject. *Pace* Strawson, Kant did not think that Hume had the conceptual apparatus to justify the conclusion that we must regard nature as if it were governed by universal and necessary laws. The account of reason that is needed to justify this conclusion is insufficient in Hume's philosophy. According to Allison,

> The assumption of nature as exhibiting a systematic unity enables Kant to explain how reason makes it possible to account for what, according to Hume, was possible only on the basis of custom, namely, the inference from the observed to the unobserved. […] Reason accomplishes this by 'projecting an order of nature', which licences the inferences from the law-like regularities discovered in the limited portion of experience with which we happen to be acquainted with at any point in time to experience as a whole. (Allison, 2008, p.142)

[21] The difference between Causation and causation is that the former is a metaphysical account, whereas the latter is derived from experience as custom or habit.

Kant mobilised reason into a faculty that is essential for our ability to view appearances as if they are law-governed and systematic, whereas Hume denied that reason could play any role in this process. Moreover, even if Strawson's account of Hume was accurate, the ability to conceive of nature as if it was law-governed does not provide sufficient warrant for the claim that nature in itself is governed by necessary causal laws. Kant's conception of laws as regulative ideas did not entail that these laws referred to any objects.

Kant's interpretation diverges from Strawson because Kant is concerned with demonstrating the limitations of Hume's philosophy. Specifically, he claims that Hume believed that laws could only be regarded as transcendent necessary connections between objects that exist independent of experience, whereas Kant is concerned with laws as transcendental necessary conditions for the possibility of experience. Kant revered Hume's philosophy for revealing the limits of metaphysics and its dogmatism in the transgressions of these limits, but the principle of doubt is an acidic principle that is equally corrosive to both transcendent and transcendental claims. To this effect, Kant described Hume's philosophy as 'the **censorship** of reason' (CPR A761/B789). Hence, Kant describes scepticism as a mere a resting-place for reason, but 'not a dwelling-place for permanent residence; for the latter can only be found in complete certainty, whether it be one of the cognition of objects themselves or the boundaries within which all our cognition of objects is enclosed' (ibid). In this sense, Hume's influence on Kant was far more extensive than his scepticism pertaining to the rational justification of causal necessity. According to Watkins, 'Kant does not so much present detailed *arguments* against skepticism as provide an *orientation* that views skepticism as an unstable position' (Watkins, 2005, p.383).

Kant explains the development of philosophy as analogous to the development from childhood to adulthood. Dogmatic metaphysics corresponds to the childhood of philosophy. Scepticism marks the intermediate stage. Unsurprisingly, the complete maturation of philosophy is marked by the *critique*, rather than the *censorship*, of reason. This description of the lineage of philosophy further emphasises Kant's distinction between transcendental realism and transcendental idealism. Hume criticised transcendental realist metaphysics because it depended on knowledge that went beyond experience, but his solution was merely to assume the presuppositions of transcendental realism were correct independent of any rational justification for them. Both the sceptical realist and Kantian interpretations of Hume agree on this point. In contrast to Strawson,

Kant's intention was not to provide an interpretation of Hume; he surely would have opposed Strawson's attempt to validate Hume's belief in transcendent metaphysical entities. Instead, Hume was a 'springboard' for the development of Kant's philosophy as he revealed the inability of reason to infer any metaphysical claims from experience pertaining to objects in themselves.

The analogy of the history of metaphysics as a developmental process is another example of how Kant appealed to physiological principles to elucidate his theory. In the previous chapter we examined Mensch's argument that Kant appealed to 'nature as a model by which to interpret reason' (Mensch, 2013, p.153). This was in relation to Kant's comments on the epigenesis of reason.[22] Kant borrowed his account of epigenesis from the physical sciences to explain the emergence of the architectonic system of transcendental idealism. He transformed epigenesis from an explanation of the origins of entities in nature to an explanation of the origin of the system of reason.[23] This enabled Kant to argue that the emergence of reason did not require further explanation; or at that least it was not possible for finite rational beings to establish such an explanation.

This appeal to epigenesis creates a potential conflict with the analogy of reason as developmental. If reason emerged epigenetically, then it already contained this a *priori* structure. This conflict is resolved if we consider the epigenesis of reason in the context of its role in the development of Kant's philosophy, whereas the lineage of reason is meant historically or anthropologically. This does not mean that reason itself has changed; only the orientation toward the understanding of reason has changed. Hence, both explanations are compatible when considered from these different perspectives.

In summary, Kant would have rejected the sceptical realist interpretation because it emphasises Hume's belief in entities that cannot be rationally justified in accordance with Hume's empiricism. I argued that Strawson's interpretation of Hume as approaching the world *as if* it were governed by necessary causal laws has a greater resemblance to the Kantian, rather than Humean, account. Moreover, in the context of Kant's philosophy, this would not support laws as relating to objects independent of experience, but instead would be regulative projections of order onto nature produced by the subject. Finally, I

[22] See Chapter One (1.2)

[23] The transformation of this concept from a ground of nature to a ground of reason led Kant to argue that organisms could not be regarded as existing independent of judgment. For Kant, organisms are a product of the power of judgment to judge nature in accordance with final causes.

considered how Kant regarded Hume's philosophy as a transitional step toward the development of critical philosophy.

2. Transcendental idealism as developing from Humean empiricism

The faculty of sensibility, discussed in the 'Transcendental Aesthetic', contains only intuitions.[24] The two forms of intuition are space and time, each of these is further divided into pure and empirical kinds. Kant's arguments for intuitions focus on two features: they are synthetic *a priori* and non-discursive. The uniqueness of intuitions depends on the demonstration of their non-discursivity or non-conceptuality. Kant argues that time is *a priori* on the following grounds:

> Time is not an empirical concept that is somehow drawn from an experience. For simultaneity or succession would not themselves come into perception if the representation of time did not ground them *a priori*. Only under its presupposition can one represent that several things exist at one and the same time (simultaneously) or in different times (successively). (CPR A30/B46)

All experience is either successive or simultaneous, but if knowledge of this were derived from experience we could not know these are necessarily the only ways that experience can be presented to us. We could only make the inductive statement that up to this point every experience has been either successive or simultaneous. At best, this argument demonstrates that the successive or simultaneous modes of time are *prior* to experiences because they are conditions that make those experiences possible; however it does not establish the *a priority* of time. The *a priority* of time requires the further proof that these conditions of experience of time are not derived empirically (*a posteriori*).

Kant's second argument attempts to demonstrate how time cannot be derived empirically in the form of a thought-experiment. Kant considers whether it is possible to think of an absence of time. He asserts 'one can very well take the appearances away from time […], but time itself (as the universal condition of their possibility) cannot be removed' (CPR A31/B46). As the abstraction of the object does not entail the abstraction

[24] The term translated as intuition is *Anschauung*. The appropriateness of this term has been disputed as *Anschauung* literally means 'atlooking' or 'atsight' and is closely related to the family of terms 'foresight' or 'insight'. These connote looking at an object in its immediate presence, whereas intuition connotes a direct, yet unexplainable, transference of information (For a more detailed discussion see the editorial discussion in *Mind* (1892) What does Anschauung Mean?)

of time, Kant concluded that time must be the condition of the possibility of the experience—rather than a property—of objects in themselves.

Allison contrasts Kant's and Hume's account of time by asking if events can be directly perceived, or does experience 'require some kind of interpretive act guided by an a priori rule?' (Allison, 2008, p.110). For Hume, no such rule is necessary, but this leads to further problems. Allison explains that Hume cannot adequately account for the perception of successive events or successive states of an object. He considers Hume's example of hearing five notes played on a flute (T 36). Hume argues that time does not form a sixth impression; however, Hume's account requires an explanation for how the mind can contain the idea of the five impressions. According to Allison,

> he [Hume] has no way to explain how, on the basis of five successive note perceptions, we can arrive at a perception of the succession of five notes. What we now learn, with the help of Kant, is that such a perception […] requires what I have termed an act of interpretation governed by an a priori rule. […] [T]he Humean mind enters the story one step too late. (Allison, 2008, p.111)

The Humean mind enters the story late because it assumes the experience of the succession of time requires no special explanation. Kant would agree with Hume insofar as the order or manner of appearances is not sufficient to establish that time is an additional impression. That is, time cannot be regarded as something additional in any particular experience. However, for Kant this serves as justification for conceiving of time as an *a priori* condition for the possibility of experience in general. From the perspective of transcendental idealism, Hume cannot explain how we first become aware of the succession of the five notes. Allison asserts that 'unless time were presupposed as the medium or framework in which this succession is perceived, one could not be conscious of the notes as successively occurring in it' (Allison, 2008, p.54).

Guyer has argued that it could be possible for space and time to be properties of objects in themselves, and our awareness of space and time to be derived empirically in the early stages of development before any formation of memory is possible (Guyer, 2006, p.66). In this case, space and time would only seem to be *a priori*, but they would be *a posteriori* as they are derived from contingent experience. If space and time are contingent, then it is impossible in principle to rule out the idea that appearances could be represented in other ways. It is also impossible to declare that objects independent of experience are necessarily devoid of space and time. Hence, Guyer argues that Kant does

not have sufficient grounds to demonstrate the necessity or the *a priority* of space and time as the only forms of intuition. Moreover, he argues that Kant concedes this as he asserts that no further ground can be offered 'for why space and time are the sole forms of our possible intuition' (CPR B146).

Guyer's interpretation of transcendental idealism leaves it defenceless against this criticism. On his view, Kant's arguments for the *a priority* of space and time is established by denying these properties to objects in themselves, but Kant requires 'some *independent reason* to hold that those epistemic conditions *could not also be* properties of objects' (Guyer, 2007, p.13). Allison has argued that Kant's position is the reverse of this claim; we are not warranted to attribute space and time to objects in themselves because they are only ever epistemic conditions. Allison's interpretation is more sympathetic to transcendental idealism:

> [T]he issue currently before us is not whether epistemic conditions might somehow be *satisfied* by things as they are in themselves, but rather whether the representations that function as such conditions (in this case the forms of sensibility) might be *derived from* an experience of things so considered. (Allison, 1996, p.25)

If knowledge of space and time pertained to things in themselves, then necessity of space and time is denied. The necessity of space and time can only be established in relation to appearances. Both Guyer and Allison agree that the success of transcendental idealism requires that space and time are grounded as *a priori* intuitions. Their differing accounts can be understood if we consider their presuppositions. Guyer argues that the two-world account was prevalent in philosophy in Kant's time; 'of course he [Kant] held a "two-object" view: everyone (except Berkeley) did, though few would have agreed with Kant's reassignment of spatio-temporal properties from ordinary objects to representations' (Guyer, 2006, p.69). The idea that space and time were reassigned from objects to representations implies that Kant needed to demonstrate that these properties could not belong to things in themselves. On the other hand, if transcendental idealism was showing the insufficient warrant for claiming that these were properties of objects, then all that is required is to demonstrate how space and time are conditions of the representations of objects. The two-aspect interpretation concedes that it is not possible to provide independent reasons to demonstrate that space and time are not conditions of objects in themselves, but it argues that this question is beyond the scope of knowledge. In other words, the presupposition that space and time should relate to things in themselves rather

than appearances is an unwarranted assumption. In this context, the two-aspect interpretation reveals that Kant's intention is to show that space and time can only be known as necessary conditions for the possibility of experience if they are understood as products of the faculty of sensibility.

The two-world and two-aspect accounts of Kant have a different application in relation to the distinction between theoretical and practical reason. This will be developed in more detail in relation to contemporary philosophers of biology who have appealed to Kant's philosophy to support aspects of their theories such as freedom and biological autonomy.[25] According to the two-world interpretation, we can assert that our autonomy is not derived from nature as nature is spatiotemporal and governed by efficient causation, whereas autonomy requires that we view ourselves as free noumenal agents. Kant explains that an individual is subject to laws when considered as an appearance that do not apply when that individual is treated as a thing in itself (G 4:457). According to Wood, we are 'simultaneously free and causally determined because we belong to two worlds' (Wood, 1984, p.74). For the sake of this argument, let us assume this interpretation is correct. This points toward a potential tension with philosophers of biology who appeal to Kant's philosophy because they will not be satisfied with any account of freedom and autonomy that is grounded in a world other than nature; biological autonomy is essentially a property of biological entities.

The two-aspect interpretation is also problematic for biological conceptions of freedom. The two-aspect view can only allow us to conceive of ourselves as abstracted 'from the causal determinations of our actions in space and time' (Guyer, 2006, p.68). This is not the same as claiming that the source of causal determination of our actions could be other than spatial and temporal. For Allison, practical reason functions by developing and projecting maxims that 'guide conduct by framing an order of ends or ought-to-bes' (Allison, 1990, p.40). This projective capacity of practical reason is just like the projective capacity of theoretical reason, both are regulative principles that guide enquiry; '[l]ike its theoretical analogy, this activity is an expression of spontaneity of reason because it goes beyond what is dictated by sensible data' (ibid). This leads Allison to distinguish rational necessity and causal necessity as only the latter are derived from antecedent conditions. In short, reasons are not causes. Freedom is not proven but

[25]This is discussed in Chapter Five.

presupposed according to Allison's interpretation; freedom is acting *as if* we are not like objects of experience that are causally determined in space and time. This is potentially unsatisfactory for contemporary accounts of freedom in philosophy of biology because freedom is not proven, rather it is presupposed.

In the context of Hume's influence on Kant, Kant appeals to his interpretation of Hume's philosophy to explain the difference between causality for theoretical and practical reason. In this sense, the two-world interpretation offers greater support to Kant's conception of practical reason insofar as Kant refers to both as causal processes. Kant explains this in the context of his rejection of Hume's denial of causality. According to Kant,

> The concept of an empirically unconditioned causality is indeed theoretically empty, since it has no appropriate intuition, even though it is still possible and refers to an indeterminate object; in compensation for this, the concept gains significance […] in the moral law and consequently in a practical relation. (CPrR 5:56)

Kant agrees with Hume regarding the theoretical emptiness of unconditioned causal necessity in respect to theoretical reason. Any such notion of causality lacks a corresponding intuition relating to a determinate object. As Allison suggests, for theoretical reason it is possible to project onto nature general laws of indeterminate objects, but these can only pertain to regulative principles that guide enquiry. In contrast, practical reason is not based on any corresponding intuitions and therefore the "objects" of practical reason are fundamentally different than objects of theoretical reason: '[b]y a concept of an object of practical reason I understand the representation of an object as an effect possible through freedom' (CPrR 5:57). It is impossible to have knowledge of objects of practical reason because they are different in kind to objects of theoretical reason.

In summary, Kant's separation of intuitions from things in themselves made it possible for him to establish space and time as necessary transcendental conditions insofar as they are understood in relation to experience. This was supported by a brief examination of the two-world and two-aspect interpretations of Kant's philosophy which considered Kant's warrant for his separation of the conditions of objects of experience from the conditions of things in themselves. I further examined how Kant's account of intuitions as relating to theoretical reason allowed him to develop practical reason as

another kind of causality that was not limited to the spatiotemporal conditions of intuitions.

3. Metaphysical arguments regarding the existence of laws

This final section examines accounts of the status of laws in contemporary philosophy of science from a Kantian perspective. The two philosophies under consideration are Cartwright's account of laws as 'nomological machines' and Bhaskar's transcendental realist account of laws. According to the latter, the existence of laws is a scientific precondition for the possibility of scientific practice, whereas the former argues there is little empirical evidence to support the existence of laws beyond their manifestations derived from scientific experiments. After outlining both accounts I argue that they can be formulated as two sides of a Kantian mathematical antinomy. Both presuppose that the conditions of experience can be applied to metaphysical arguments that pertain to entities beyond appearance. Moreover, despite the obvious divergence between their accounts regarding the existence of universal laws, there are also important points of similarity. I argue that both accounts presuppose that it is possible to regard science as unified, albeit in different ways. Bhaskar locates this unity in universal transfactual laws of nature, whereas Cartwright's account identifies unity at the level of causal capacities, rather than laws, depends on the universality of logical principles such as non-contradiction and sufficient reason. I argue that these accounts do not consider the boundaries of knowledge identified by transcendental idealism, despite both offering incompatible transcendental arguments for their position. I argue this reinforces the argument that transcendental arguments cannot be sufficiently supported in the absence of the distinction between the empirical reality and transcendental ideality of appearances.

1. Bhaskar's transcendental realism and Cartwright's nomological pluralism

Cartwright and Bhaskar emphatically oppose Kant's critical philosophy. Cartwright criticises transcendental idealism on the basis that it imposes an unrecognisable image of reality. According to Cartwright, transcendental arguments

> appear in the clean and orderly world of pure reason as refugees with neither proper papers nor proper introductions, of suspect worth and suspicious origin. The facts which I take to ground objectivity are similarly alien in the clear, well-lighted streets of reason, where properties have exact boundaries, rules are unambiguous, and behaviour is precisely ordained. (Cartwright, 1999, p.23)

Cartwright's reflection on the 'alien' nature of transcendental arguments highlights the differences between the transcendental methodology and the methodologies adopted by many contemporary philosophers. The notion that Kant's streets of reason are 'well-lighted' with 'exact and unambiguous boundaries' conflates the goal of transcendental idealism with its procedure. Kant's intention is to provide the basis for the possibility of any future metaphysics,[26] not to provide an exhaustive account of the content of this metaphysics. Cartwright's empiricism opposes the possibility of the foundation that Kant elaborated as she argues there is no empirical justification for the assumption that nature conforms to these principles.

Bhaskar opposes transcendental idealism because he regards it as a continuation of empiricism. Bhaskar argues that Hume's empiricism entails the ontological denial of the existence of necessary laws of nature; 'the empiricist fills the [ontological] vacuum he creates with his concepts of experience. In this way an implicit ontology, crystallized in the concept of the empirical world, is generated' (Bhaskar, 2008, p.40). Any justification for scientific enquiry is denied by Hume's ontology because it denies any knowledge of the laws that are presupposed by such an enquiry.[27] This similarity between transcendental idealism and empiricism is the reason for its ultimate inadequacy. According to Bhaskar, 'although transcendental idealism rejects the empiricist account of science, it tacitly takes over the empiricist account of being' (Bhaskar, 2008, p.28). Both transcendental idealism and empiricism are committed to empirical realism. Empirical realism is not inherently problematic; however, it becomes problematic when it is regarded as an exhaustive account of the domain of human activity. This criticism does not accurately represent Kant's philosophy as many aspects of human activity are not justified in accordance with empirical realism. For instance, Kant argues that the power of judgment and practical reason cannot be appropriately justified in relation to theoretical

[26] This is evident from the title of Kant's *Prolegomena to any Future Metaphysics*.

[27] This is an example of the conflation of Hume's epistemology with his ontology that Galen Strawson opposed. Whilst Hume denied any rational basis for such laws, our belief in these laws was derived from habit. Hume's rational doubt of universal laws was restricted to a mere academic exercise. Kant's critical philosophy is an attempt to make Hume's philosophy into a substantive theory about the limitations of our human capacities.

philosophy, but he is nonetheless committed to experience as the ground for theoretical knowledge and the theoretical deployment of reason. According to Kant, '[a]ll of our cognition is in the end related to possible intuitions: for through these alone an object is given' (CPR A719/B747).

Bhaskar's criticism correctly identifies the empirical realist implications of Kant's conception of theoretical reason. This has been missed by other criticisms of Kant's philosophy such as the equivocation between transcendental idealism and Berkeleyian idealism.[28] Kant distinguished his philosophy from Berkeley's on the basis that his philosophy provided the means for distinguishing truth from illusion. Only transcendental idealism could establish transcendental principles that were necessary for the possibility of experience. According to Kant,

> For *Berkeley* experience could have no criteria for truth, because its appearances (according to him) had nothing underlying them *a priori*; from which it followed that experience is nothing but sheer illusion, whereas for us space and time (in conjunction with the pure concepts of the understanding) prescribe *a priori* their law to all possible experience, which law at the same time provides the sure criterion for distinguishing truth from illusion in experience. (P 4:375)

Kant avoided the implications of Berkeley's empirical idealism by aligning his philosophy to Hume's empirical realism. Kant's response to Berkeleyian idealism is to show that knowledge can only arise when concepts are applied to intuitions. Theoretical claims that lack any reference to intuitions cannot be justified because there is no way to demonstrate how these claims correspond to an object. *Pace* Kant, Bhaskar suggests that being is necessary at both the epistemological and ontological levels. According to Bhaskar, 'we can allow that experience is in the last instance epistemically decisive, without supposing that its objects are ontologically ultimate, in the sense that their existence depends on nothing else' (Bhaskar, 2008, p.38). Bhaskar argues that ontology is distinct from epistemology insofar as the role of philosophy is to furnish science with an ontology that promotes the flourishing of science (Bhaskar, 1989, p.183). Ontology is a hand maiden to science for Bhaskar: '[o]ntology, it should be stressed, does not have as its subject matter a world apart from that investigated by science' (Bhaskar, 2008, p.36). In this way Bhaskar demarcates the appropriate domain of ontological enquiry. Any

[28] This criticism was most famously raised by Garve's review of the *Critique of Pure Reason.* This is included in the Cambridge University Press translation of Kant's *Prolegomena to Any Future Metaphysics* (pp.201-7).

philosophy that either pursues ontological enquiries independent from the sciences, or rejects the possibility of a realist ontology of science, is invalid. This is opposed to the approach toward the philosophy of science developed throughout this thesis which examines the various ways that philosophers of biology have appealed to aspects of Kant's philosophy. This is not aimed at providing an appropriate conception of ontology for contemporary philosophy of science. Rather, it is concerned with exploring the contextual factors that contributed to the development of these philosophies of science. It allows us to understand why these philosophies appealed to Kant and explores the subsequent influence of Kant's philosophy on the development of these sciences. In many cases, it reveals internal tensions inhering within these philosophies because of incompatibilities between transcendental idealism and naturalism.

In the previous chapter, Kant's critique of transcendental realism was discussed. For Kant, transcendental realism entails that the conditions of knowledge of appearances are treated as the conditions of knowledge of things in themselves. [29] Bhaskar avoids this by distinguishing the transitive and intransitive aspects of scientific enquiry. The transitive objects of science relate to the aspects of a theory that constitute its empirical verification. These are the raw materials of science which include the techniques and apparatus available to scientists. This is a process of constructing an environment that imposes an artificial closure on nature for the purposes of scientific enquiry. A scientific experiment requires that the conditions of experimental production and experimental closure are achieved. The former entails that an experiment must trigger a relevant natural mechanism, the latter entails that all other variables are isolated. To put it in more Kantian terms; without experimental production, an experiment would be empty as no mechanism would be triggered; without experimental closure, the experimenter would be blind to other mechanisms that could invalidate any results. Bhaskar explains that the regularities established in an experiment are not generally reflected in nature beyond these experimental conditions. According to Bhaskar,

> The aim of an experiment is to get a single mechanism going in isolation and record its effects. Outside a closed system these will normally be affected by the operations of other mechanisms […] so that no unique relationship between the variables or precise description of the mode of operation of the mechanism will be possible. (Bhaskar, 2008, p.53)

[29] See Chapter One (1.3).

The mechanisms discovered in a closed system or scientific experiment, which are transitive objects, do not entail that the regularity of these mechanisms extends to open systems, which are intransitive objects of science. Recall that for Hume, even if an effect were to follow a cause without exception, it would still not warrant us to derive the necessary connection between these events from our experience of their constant conjunction. Bhaskar and Cartwright both agree that nature does not generally conform to this regularity beyond the context of scientific experimentation. They diverge because Bhaskar argues for the realism of laws as a rational condition for the possibility of science, whereas Cartwright argues that there is no empirical basis for the existence of universal laws.

For Bhaskar, knowledge of how these laws act in open systems independently from scientific enquiry is not a requirement for concluding that scientific enquiry is examining those same laws in closed systems. According to Bhaskar,

> The transcendental realist sees the various sciences as attempting to understand things and structures in themselves, at their own level of being, without making reference to the diverse conditions under which they exist and act, and as making causal claims which are specific to the events and individuals concerned. And he sees this not just as a tactic or manoeuvre or mechanism of knowledge; but as according with the way things really are, the way things must be if our knowledge of them is to be possible. (Bhaskar, 2008, p.78)

This is transcendental because it is an explanation of how scientific laws must be the case for the possibility of scientific knowledge; however, this certainty does not require empirical verification. We cannot know the actions of these laws independent of scientific enquiry in open systems more generally, nevertheless we must consider these laws as constantly acting irrespective of the absence of their regularity in nature. Bhaskar terms causal laws *transfactual* statements. Laws must necessarily be regarded as acting independently from our knowledge of them, and science is the contingent enquiry into these laws that is specific to human activity. In Bhaskar's terms, the former relates to intransitive objects, the latter relates to transitive objects. The intransitive objects of science persist independent of transitive scientific enquiry; '[w]e can easily imagine a world similar to ours, containing the same intransitive objects of scientific knowledge, but without any science to produce knowledge of them' (Bhaskar, 2008, p.22). It is important to distinguish the claim that intransitive objects are necessary for the possibility of science from his claim that the same intransitive objects are conceivable in a different world. The latter statement is problematic because it does not follow from the mere

conceivability of another world, with the same intransitive objects of science, that these intransitive objects are *necessary* for all possible worlds. The former is merely asserting that whilst the discovery of any theory is contingent, the *intransitive* laws that make that discovery possible are necessary independent of that experience. Even if the absence of the intransitive aspects of science were unimaginable, this only demonstrates, at best, the psychological necessity—rather than the ontological necessity—of scientific laws independent of experience. Ontology posits the existence of metaphysical entities, whereas psychology posits such entities as necessary for the subject.

The *intransitive* aspects of science allows Bhaskar to resolve the tension between necessity and contingency in the development of scientific practice. Whilst the discovery of the theory is contingent, the *intransitive* laws that are the content of that discovery are necessary independent of experience. Bhaskar's claim that this amounts to a transcendental justification of laws independent of experience is insufficient. For Bhaskar, the practice of science requires the ontological necessity of intransitive laws, and it is the purpose of philosophy to furnish science with this ontology. The essential difference between Bhaskar and Cartwright is that the former provides a rationalist argument for the existence of laws whereas the latter endorses a critical empiricism with respect to laws. For Cartwright, evidence has generally demonstrated that laws are context-specific, rather than being fundamental and universal regularities that persist throughout nature. According to Cartwright, '[m]etaphysical nomological pluralism is the doctrine that nature is governed in different domains by different systems of laws not necessarily related to each other in any systematic or uniform way; by a patchwork of laws' (Cartwright, 1999, p.31). A law is the nomological machine that is produced in the context of experimental conditions; '[t]o grant that a law is true […] is far from admitting that it is universal—that it holds everywhere and governs in all domains' (Cartwright, 1999, p.24). Cartwright's account of nomological machines is similar to Bhaskar's account of the transitive objects of science as both describe the context-specificity of scientific research. Cartwright diverges from Bhaskar because she claims that the successes of scientific research demonstrates its context-specificity. She argues that some of the best examples of scientific progress focus on the context-specific background of capacities in nature. Aviation is a paradigm example of harnessing these capacities to produce regularity with great effect; this is one of many examples that demonstrate that we construct entities 'to fit the models we know work. Indeed, that is how we manage to

get so much into the domain of the laws we know' (Cartwright, 1999, p.28). Understanding laws as context-specific does not require that laws possess a predictive capacity beyond the context from which they are derived. On the contrary, nomological pluralism suggests that scientific research should be expanding our understanding of laws by directing research toward similar local models where we could reasonably predict that similar natural capacities and laws might be present.

Cartwright is not denying the possibility of a unified science more generally, she is only denying that this unity could be understood under a model that considers laws as fundamental and universal regularities. The empirical evidence to support this account of laws is generally very weak, not merely because of the problem concerning deductive knowledge of laws based on inductive inferences, but because science has demonstrated that nature rarely expresses lawlike regularity. Newtonian mechanics was exceptional because it discovered lawlike regularity and became a paradigm that both science and philosophy strove to achieve. However, such lawlike regularity has rarely been discovered without imposing a plethora of *ceteris paribus* conditions. According to Dupré, 'far from knowing that these laws are universally true, we know that they are generally false' (Dupré, 2001, p.166). Cartwright is not suggesting that laws are false, merely that we falsely infer that laws continue to act independently from their scientific context. We must have reasons to suggest that any law extends beyond the nomological machine that demonstrated it. For Cartwright, this suggests the need to focus on the natural capacities that form the context of the law. According to Cartwright,

> I do not deny the unifying power of the principles of physics. But I do deny that these principles can generally be reconstructed as regularity laws. If one wants to see their unifying power, they are far better rendered as claims about capacities, capacities that can be assembled and reassembled in different nomological machines, unending in their variety, to give rise to different laws. (Cartwright, 1999, p.52)

Cartwright's appeal to capacities as the basis for the unity of science is diametrically opposed to Bhaskar's account. She reverses the relationship between experiment and laws on the one hand, and laws and unity on the other. Laws are the product of scientific experiments, and a more appropriate ground for a unified science focuses on the various ways that natural capacities can be assembled and reassembled.

2. A mathematical antinomy: Bhaskar and Cartwright

The difference between the positions of Bhaskar and Cartwright can be understood as developing metaphysical arguments from the opposed perspectives of rationalism and empiricism. In this sense, these arguments can be formulated as an antinomy consistent with the form that Kant offers in the First *Critique.* The importance of the antinomies cannot be underemphasised. In a letter to Garve in 1798, Kant confirmed that it was the antinomies which 'first aroused me from my dogmatic slumber and drove me to the critique of reason itself, in order to resolve the scandal of ostensible contradiction with reason itself' (C 12:257-8). For Kant, these contradictions of reason arise naturally, but they are indicative of the tendency of reason to overstep the boundaries of knowledge. Kant distinguishes between two types of antinomy in the First *Critique*. These are mathematical antinomies and dynamical antinomies. The former relate to cases where both sides of the contradiction depend on a shared assumption. Kant describes this as 'a **synthesis of homogeneous things**', whereas the latter is 'a synthesis of **things not homogeneous**' (CPR A530/B558). Kant continues to explain how mathematical antinomies require that both sides of the argument refer to a sensible condition, whereas dynamical antinomies relates to cases where one side of the argument refers to a sensible condition and the other refers to an intelligible condition. Kant's antinomies in the First *Critique* take the form of reductio ad absurdum arguments. This argumentative form offers justification for an initial position by assuming the opposite stance and revealing the internal inconsistency of the position and its contradictory implications. As the opposite stance is contradictory, this offers support to the initial position as it is assumed as the only possible alternative. When the proofs for both the thesis and the antithesis are considered in combination, each offers criticism against the other. Kant describes this as 'open[ing] up a dialectical battlefield, where each party will keep the upper hand as long as it is allowed to attack, and will certainly defeat that which is compelled to conduct itself merely defensively' (CPR A422-3/B450). This allows Kant to subject both sides of the antinomy to what he terms the sceptical method. This is distinct from scepticism as the former is directed toward establishing certainty by 'seeking to discover the point of misunderstanding in disputes that are honestly intended and conducted with intelligence by both sides' (CPR A424/B451-2). In contrast, the latter is concerned with undermining the foundation of all cognition and uprooting any possibility for certainty. Bhaskar's and Cartwright's accounts can be constructed as the thesis and antithesis of an antinomy in the following form:

Thesis: Scientific research is discovering the existence of universal transfactual laws; the laws of nature are not 'dappled'.

Proof: On the assumption that there are no universal transfactual laws of nature, it follows that it would be impossible to establish transitive regularity at the empirical level in scientific conditions. We can identify such regularity, therefore the assumption that there are no universal transfactual laws is false.

Antithesis: There are no universal transfactual laws of nature; the laws of nature are 'dappled'.

Proof: On the assumption that there were universal transfactual laws in nature, it follows that the regularity of such laws would be demonstrated in experience. Experience rarely reveals the manifestation of lawlike regularity across nature, rather it suggests that laws are the context-specific manifestations of regularity. These manifestations are generally the product of scientific experimental conditions, but they are also infrequently found in conditions free from human intervention such as celestial orbits. This demonstrates that the experience of laws is always context-specific, and thus the assumption of universal transfactual laws of nature is false.

Both the thesis and the antithesis agree insofar as empirical lawlike-regularity is not sufficient to justify the existence of universal laws. The difference is that Bhaskar argues that the partial regularity at the empirical and scientific levels requires the existence of transfactual universal laws. According to Bhaskar,

> [t]he analysis of experimental activity shows, then, that the assertion of a causal law entails the possibility of a *non-human world*, that it would operate even if it were unknown, just as it continues to operate when its consequent is unrealized (or if it is unperceived or undetected by human beings), that is, outside the conditions that permits its empirical identification' (Bhaskar, 1989, p.17)

Empirical scientific observations tend to oppose, rather than confirm, the regularity of transfactual laws of nature. Nevertheless, the empirical irregularity of laws does not jeopardize, but in fact supports, the conception of laws as regular and universal at the non-human transfactual level. This brings into focus the differing commitments towards rationalism and empiricism held by Bhaskar and Cartwright. Bhaskar's orientation

toward rationalism leads him to argue that laws 'are neither empirical statements (statements about experiences) nor statements about events. Rather they are statements about the ways of acting of independently existing and transfactually active things' (Bhaskar, 2008, p.52). In contrast, Cartwright's empiricism draws from the same irregularity of laws at the empirical level in support of the conclusion that laws are nothing more than their context-specific manifestations. Both accounts presuppose that the conditions of experience can provide access to the conditions of nature independent of experience at the non-human level. As previously noted, this does not mean that Cartwright is denying a more general conception of science as unified, she is merely denying that such unity occurs at the level of universal and transfactual laws. Her account implicitly requires the existence of universal logical laws that make it possible to state that laws are dappled and not universal. This requires that both the principle of non-contradiction and the principle of sufficient reason are present throughout the universe. In other words, her account depends on the claim that laws are dappled and not otherwise, and it is possible to provide sufficient reasons why this is the case. Kant was critical of empiricism because its advocates often fail to recognise its limits and dogmatically deny the possibility of other aspects of human activities that cannot be accounted for solely in relation to appearances. According to Kant,

> if empiricism itself becomes dogmatic […] and boldly denies whatever lies beyond the sphere of its intuitive cognitions, then it itself makes the same mistake of immodesty, which is all the more blamable here, because it causes an irreparable disadvantage to the practical interests of reason. (CPR A471/B499)

Kant's criticism focuses on the denial of what lies beyond intuitions, but it also implies that the empiricist extends the conditions of knowledge specific to experience to all forms of possible knowledge. The result is that the empiricist is unable to recognise their unjustified extension of the conditions of appearances to domains which are not empirical. When applied to Cartwright's account, it is not possible to offer justification for the claim that nature independent of experience would be required to conform to the logical principles of non-contradiction and sufficient reason.

The resolution of the antinomy between Bhaskar's rationalism and Cartwright's empiricism in relation to the justification of universal laws of nature offers further support to transcendental idealism, namely 'that appearances in general are nothing outside our representations, which is just what we mean by their transcendental ideality' (CPR

A507/B535). Kant's account suggests that the resolution of the antinomies consists in recognising that the dichotomy between the thesis and the antithesis arises from the assumption that the entities in question can be understood in accordance with the conditions of experience. The thesis and the antithesis are deemed to be contradictory opposites. This means that disproving the alternative position is considered as sufficient proof for the remaining side of the argument. If its opposite can be proved to be false, then it necessarily entails the truth of the alternative. However, Kant argues that transcendental idealism establishes a third option for mathematical antinomies, namely that both the thesis and the antithesis are false. According to Kant, '[i]f someone said that every body either smells good or smells not good, then there is a third possibility, namely that a body has no smell (aroma) at all, and thus both conflicting propositions can be false' (CPR A503/B531). In relation to this antinomy, both the thesis and the antithesis presuppose that the conditions for the existence of universal laws can be derived from experience. In this sense, they extend the possibility of knowledge beyond the remit identified by Kant's critical philosophy.[30] Both Bhaskar and Cartwright not only go beyond the remit of knowledge outlined by Kant, moreover they attempt to offer transcendental arguments to justify their positions. I will now examine these arguments to demonstrate that transcendental arguments require the distinction between the conditions of knowledge of appearances and the conditions of knowledge of things-in-them-selves.

3. Transcendental arguments in Bhaskar's and Cartwright's accounts.

Both Bhaskar and Cartwright regard their philosophies as establishing transcendental certainty at an ontological level. Cartwright argues that the basis of Kant's transcendental arguments such as the kingdom of ends or the transcendental unity of apperception are puzzling and obscure. Instead, the basis of her transcendental argument is '[t]he objectivity of local knowledge' (Cartwright, 1999, p.23). Clarke explains Cartwright's transcendental argument as follows: the possibility of scientific practice in general[31] requires the objectivity of local knowledge. As scientific practice in general is possible, it follows that the objectivity of local knowledge must also be possible. According to Clarke, Bhaskar's and Cartwright's transcendental arguments are incompatible;

[30] Kant's alternative transcendental account of the relation between the need to presuppose laws despite the inability for experience to offer exhaustive proof of such laws is discussed in the next chapter in relation to the differences between the accounts of science of Kant and Whewell.
[31] Cartwright includes planning, prediction, manipulation, control and policy setting.

> Each undermines the credibility of the other. Bhaskar is not merely offering us one possible way of accounting for the experimental practices of scientists. He is claiming that this is the only way to account for the experimental practices of scientists. […] Cartwright's transcendental local realism involves a rival account of the elements of scientific practice that Bhaskar did not consider.
>
> (Clarke, S., 2010, p.310)

Neither Bhaskar nor Cartwright successfully demonstrate what the ontology of science *must* be. There are well-established arguments against the possibility of using transcendental arguments to demonstrate certainty about the world independent of experience. According to Stroud, transcendental arguments must depend on the implicit assumption that because the world appears a certain way, then it *must* be that way. Stroud argues that this presupposes we are warranted to make the connection between metaphysics and appearances from the fact of having that appearance. A sceptical position can show that although we might be required to *believe* certain metaphysical principles, this does not entail the truth of those principles. According to Stroud, '[t]he skeptic distinguishes between the conditions necessary for a paradigmatic or warranted (and therefore meaningful) use of an expression or statement and the conditions under which it is true' (Stroud, 1968, p.255). Stern summarises Stroud's position as attempting to render problematic any argument 'which asserts that "non-psychological facts" about the world outside us constitute necessary conditions for our thinking' (Stern, 2007, p.145).

Both Stroud and Stern emphasise that the primary function of transcendental arguments is to defeat scepticism. They also agree that the call to answer global scepticism, i.e. doubting the existence of objects independent of experience, is beyond the remit of transcendental arguments. Transcendental arguments potentially answer the modest sceptic if they are only intended to demonstrate the necessary conditions of experience.[32] Neither Bhaskar nor Cartwright regard transcendental arguments as merely answering the modest sceptic by identifying conditions for the possibility of experience. In this sense, their use of transcendental arguments is problematic because both attempt to use them to ground ontological necessity. Clarke argues that neither is attempting to reject global scepticism through their use of transcendental arguments, but this must

[32] Stern criticises Stroud for assuming that the difference in modality between claims about existence independent of experience and claims about conditions of experience is sufficient to deny the possibility of transcendental arguments pertaining to the external world without further justification.

ultimately mean that they fail to demonstrate the necessity of the ontological content of their conclusions.

In summary, the ontological accounts of laws developed by Cartwright and Bhaskar do not offer sufficient support to justify their transcendental conclusions. For Bhaskar, the possibility of science requires that there are intransitive transfactual laws that we can direct transitive enquiry towards. In contrast, for Cartwright the unity of science should not be understood as relating to intransitive laws, rather laws do not exist beyond their context-specific manifestations. The unity of nature does not relate to laws, but rather to capacities that can be assembled and reassembled. These capacities can be manipulated in scientific experiments to establish laws that are essentially context-specific. The incompatibility between these two arguments brings into question their transcendental status as a condition for a transcendental argument is that no alternative explanation is possible. The problem is that both sides of the argument venture into transcendental realism because they assume that the experience of objects can be used to justify metaphysical claims about objects independent of experience.

Conclusion

This chapter began by examining Hume's influence on Kant. One source of motivation for the development of transcendental idealism was the errors that Kant believed Hume had made. He argued that Hume's division between matters of facts and relations of ideas were based on the logical necessity of the latter which was true independent of experience. In this sense, Kant accused Hume of protecting his account of mathematics from scepticism as he did not consider how mathematics could be grounded synthetically. Kant misunderstood Hume's philosophy as Hume had argued that relations of ideas were derived from psychologistic necessity which required the demonstration of an axiom, proof or theorem as a ground for its certainty. In this sense, Hume did not distinguish between matters of facts and relations of ideas on the basis that the former related to synthetic statements and the latter to analytic statements. Rather both were synthetic, and the difference was that knowledge of causal matters of facts could only be justified in relation to habit, whereas relations of ideas were justified rationally. Kant remained unaware of the similarity between his own account of synthetic *a priori* knowledge and Hume's account of mathematics because of this misunderstanding. Kant thought that if

Hume had realised that relations of ideas had a synthetic ground, then this would have allowed him to revise his entire philosophy to understand how the subject could be the condition of necessity for both mathematics and causality.

Kant's interpretation of Hume was compared with the sceptical realist interpretation. The sceptical realist suggests that Hume was not an ontological antirealist regarding causal laws, but only an epistemic antirealist. Kant would have opposed the sceptical realist because they regard Hume's appeal to habit as justification for Hume's belief in metaphysical causation. In contrast, Kant argued that the virtue of Hume's philosophy was his demonstration that it was not possible to offer any rational justification for a transcendental realist account that regarded the conditions of the appearance of objects as identical to conditions of objects in themselves. Kant argued that this revealed why knowledge could not pertain to things in themselves, rather than suggesting that we ought to continue to believe in causal necessity as a matter of habit.

I examined Kant's distinction between the appearance of objects and objects in themselves in relation to the two-world and two-aspect accounts of Kant's philosophy. Guyer argued that Kant had not provided sufficient reasons for why space and time could not be properties of objects in themselves. Allison's two-aspect view correctly identifies that Kant's primary concern relates to our lack of warrant to claim space and time could be regarded as properties of objects in themselves, rather than a refutation of any such possibility. In relation to Kant's practical philosophy, I considered how these interpretations offered differing explanations of the relation between freedom and causality. The two-world account argues that freedom is causal insofar as we consider ourselves as noumenal agents. In contrast, the two-aspect view argued that freedom is based on reason, but these reasons cannot be considered as causal. This was discussed in relation to its potential significance for contemporary philosophers of biology who have appealed to Kant to support their accounts.

Finally, I examined metaphysical arguments regarding the status of laws in contemporary philosophy of science by comparing Bhaskar's and Cartwright's accounts. Both propose alternative and incompatible transcendental arguments in support of their theories. I argue that these transcendental justifications are not successful because they are directed toward proving the conditions of objects independent of experience.

Chapter Three: Kant's influence on Whewell

Introduction

Kant's role in the development of philosophy of biology is widely recognised despite Kant's discussion of teleological judgment emerging from issues specific to the development of transcendental idealism, rather than biology. According to Grene and Depew, Kant's conception of teleology plays 'only a supporting role in the overall line of argument in the *Critique of Judgment*' (Grene and Depew, 2004, p.92). Kant describes the aim of the Third *Critique* as an attempt to establish a bridge that mediates the domain of theoretical and practical philosophy through the examination of the power of judgment (CJ 5:195). In this sense, it is not merely that the discussion of teleology plays a 'supporting role' in the Third *Critique*, moreover it was intended to resolve broader tensions within transcendental idealism concerning the compatibility between the First and Second *Critiques*.

Discussions of Kant's influence on biology tend to focus solely on Kant's account of teleological judgments. For Kant, a causality other than efficient causation is required to conceive of an entity as possessing the capacity for self-organisation. This causality cannot be derived from experience, rather it is derived from the faculty of judgment. Kant famously argued we could not hope for another scientist of the calibre of Newton 'who could make comprehensible even the generation of a blade of grass according to natural laws that no intention has ordered' (CJ 5:400). The role of final causes for biology is still a matter of dispute. For instance, Ruse argues that Kant was correct to show that biology utilises the metaphor of design with great success. According to Ruse, '[w]ithout the metaphor, the science would grind to a halt, if indeed it even got started. […] Whatever the ultimate logic of the case, at the practical, real-life level, Kant got it right' (Ruse, 2003, p.285). This appeal to Kant is potentially misleading as Kant's conception of teleological judgments is not metaphorical in the heuristic sense, rather teleological judgments are necessary for the possibility of any experience of organisms.[33]

[33] This relates more broadly to the potential incompatibility between transcendental idealism and naturalism discussed in the Chapter One. This account of Kant's influence on the development of biology differs from the previous discussion of Lenoir's account of Kant's influence on the development of biology in 19th century Germany. Lenoir was criticised on the basis that he had not sufficiently accounted for the incompatibility between transcendental idealism and naturalism, whereas the present account of Kant's

This brief introduction shows that Kant's conception of biology is regarded as important both for the history of biology and for resolving certain issues in contemporary philosophy of biology. The aspects of Kant's philosophy that are most frequently appealed to by contemporary philosophers of biology, such as Kant's regulative or "metaphorical" principle of natural purpose, are not the only aspects of Kant's philosophy that have been influential.[34] This chapter examines the extent to which Kant's philosophy influenced the development of biology in the British Isles in the 19th Century. I argue Kant indirectly influenced features of Darwin's theory of natural selection through his influence on William Whewell. Whewell recognised in Kant's philosophy the importance of the active powers of the mind for the acquisition of knowledge. Like Kant, Whewell regarded knowledge as the product of two irreducible sources, yet Whewell was also dissatisfied with the implications that Kant's philosophy had for scientific knowledge. Whewell took issue with Kant's denial of knowledge of things in themselves and his restriction of potential knowledge to the fixed pure categories of the understanding and intuitions. Instead, Whewell argued that knowledge was the product of the fundamental antithesis between ideas and things; he described this as the 'ultimate problem of philosophy'. This enabled Whewell to consider his philosophy of science as directly relating to things in themselves. This was the foundation of Whewell's philosophy of science from which he developed his account of the relation between facts and theories, induction, colligation of facts, and the consilience of inductions.

The conception of influence developed in the first chapter helps us to appreciate how Kant influenced Whewell without presupposing that his philosophy must be consistent with all aspects of Kant's philosophy. On this basis I offer a resolution to disagreements in Whewell scholarship surrounding the extent of Kant's influence. On the one side it has been argued that Kant did not influence Whewell's philosophy because Whewell does not discuss Kant's philosophy during the period when he developed his philosophy of science. In contrast, others have argued that Whewell was a 'Kantian prodigy'. I offer a middle ground between these existing antipodal accounts which recognises the significance of Kant's influence without presupposing that Whewell and Kant are both engaged in the same research project.

---

influence on biology in the British Isles considers this incompatibility as a central issue for understanding how Kant's philosophy was modified by Whewell's philosophy of science.

[34]I critically examine appeals to various aspects of Kant's critical philosophy—including his discussion of teleological judgment—within contemporary philosophy of biology in Chapter Five.

This examination of Kant's influence on Whewell makes it possible to understand how each philosopher grounds his methodological principles in the context of their broader philosophies. Specifically, Kant establishes an equivalent principle to consilience—positing unity as a regulative demand of reason—which is justified by transcendental logic as a synthetic *a priori* precondition for the possibility of science. Whewell's justification of consilience draws from the history of science as supporting his claim that science has been a progressive discipline that already instantiates consilience. Whewell developed a methodology that justified the prevalent beliefs amongst scientists of his time as establishing true theories about nature which discover its underlying unity. It was not merely a philosophy *of* science, but a philosophy *for* science.[35] Whewell's dissatisfaction with Kant's philosophy is that it denied the possibility of deriving science from an *a posteriori* hypothesis which then becomes an *a priori* principle of science. Whewell's account of the colligation of facts and the consilience of inductions attempts to demonstrate how this occurs within scientific practice. According to Walsh, 'Whewell's final position is that regulative principles become constitutive' (Walsh, 1962, p.142). I argue that Whewell's dissatisfaction with Kant's philosophy contributed to the development of Whewell's philosophy of science and ultimately resulted in the need for Whewell to attempt to resolve the fundamental antithesis between thoughts and things theologically.

The second section of this chapter considers appeals to the unity of science in contemporary philosophy of science. First, accounts that have appealed to Kant's philosophy as potentially aiding contemporary philosophy of science are critically examined. I argue that whilst these contemporary accounts promote certain aspects of the spirit of Kant's philosophy, other aspects are closer to Whewell's philosophy of science. Second, I consider appeals to consilience in contemporary philosophy of science and assess how the principle has changed over time. For Whewell, the principle was primarily methodological whereas for many contemporary philosophers of science, the principle is metaphysical.

[35] In this sense, Whewell's philosophy is similar to Bhaskar's account of the relation between philosophy and science discussed in the previous chapter. (cf. Bhaskar, 1991, p.141).

1. The relationship between Whewell and Kant

This section examines Kant's influence on Whewell's philosophy. Kant's influence has been the source of dispute in scholarship as there are significant differences between their philosophies. I argue that Kant's influence can be detected in the following three aspects of Whewell's philosophy: his account of the active powers of the mind, his account of knowledge as the product of two irreducibly distinct sources, and his account of consilience. Whewell was dissatisfied with various aspects of Kant's critical philosophy including his reduction of possible knowledge to the fixed forms of the categories and his denial of knowledge of things in themselves. For Whewell these aspects of Kant's philosophy had significant limitations for scientific knowledge. *Pace* Kant, Whewell argued that scientific knowledge related to things in themselves. Knowledge is the product of the fundamental antithesis between thoughts (or ideas) and things. New scientific theories arise when ideas are applied to things in a novel way. I outline the different stages of Whewell's account of scientific knowledge such as the colligation of facts and the consilience of inductions. Whewell's commitment to realism, in contrast to Kant's transcendental idealism, requires Whewell to demonstrate how consilience is not merely a pragmatic virtue for knowledge, but also is an inherent feature of nature. His appeal to theology to explain how science provides the correct account of nature is critically examined from the perspective of transcendental idealism.

1. The similarities and differences between the philosophies of Kant and Whewell

Kant's influence on Whewell is widely (but not universally) accepted in the literature. According to Ducheyne, 'Whewell learned from Kant's philosophy the importance of the active powers of reason. […] He stressed that in order to know we must perceive and conceive. Knowledge implies both passive as well as active thought' (Ducheyne, 2011, p.35).[36] Whewell's account differed from transcendental idealism because he regarded the categories and intuitions as both belonging to 'ideas'. According to Butts, 'Whewell's Fundamental Ideas are simply Kant's forms of intuition and categories under a new name' (Butts, 1993, p.192).

[36] For more accounts of Kant's influence on Whewell (Cf. Butts, 1993; Ruse, 1975)

Like Kant, Whewell regarded space, time, and causality as conditions of experience that were derived from the subject. However, the argument that categories and intuitions both belonged to the same faculty was specific to Whewell. Recall that for Kant, intuitions refer to the way that objects are given to us in space and time, whereas concepts relate to the way that objects are thought. Only the former guarantees the existence of its object as it is possible to think of an object without any such object existing, but the object is *given* to experience through intuition (P 4:290). These faculties are different in kind because each has different representational content. According to Kant, 'these two faculties cannot exchange their functions. The understanding is not capable of intuiting anything, and the senses are not capable of thinking anything. Only from their unification can cognition arise' (CPR A51/B75). Sensibility furnishes the understanding with the content of knowledge; the understanding 'can never overstep the limits of sensibility, within which alone objects are given to us' (CPR A245/B303). This does not mean that the understanding literally *cannot* overstep the limits of sensibility, rather the understanding *should* not overstep the limits of sensibility because the categories only pertain to knowledge in their empirical use. The categories could only apply to things in themselves if the conditions for things in themselves and appearances are identical. For Kant, this is fundamental to the distinction between transcendental idealism and transcendental realism.[37]

Whewell is not a transcendental realist insofar as he does not regard the conditions of things in themselves as identical to the conditions of experience. According to Whewell, knowledge of necessity cannot be derived from experience; '*Necessary truths derive their necessity from the ideas which they involve; and the existence of necessary truths proves the existence of Ideas not generated by experience*' (NOR p.7). The difference between Kant's and Whewell's conceptions of necessity can be explained in relation to their different responses to Hume. In the previous chapter I explained how Kant accepted Hume's argument that causal necessity was deceptive and illusory if it related to objects in themselves. Kant's separation of objects in themselves from objects of appearance enabled him to 'not only prove the objective reality of the concept of a cause with reference to objects of experience but also *deduce* it as an a priori concept' (CPrR 5:53).[38] Whewell agreed that causal necessity cannot be known as a property of

[37] This was discussed in Chapter One (1.3)
[38] See Chapter Two (1.2)

objects in themselves. However, he denied that we must have recourse to objects of appearance at the cost of knowledge of things in themselves to discover this source of necessity.[39] That the source of necessity could not be the object in itself led Whewell to argue that it must be derived from a different source; namely ideas. Whilst he acknowledged the difference (the fundamental antithesis) between things and ideas, he did not regard this as entailing that experience and knowledge are not directly related to objects in themselves. In this sense, Whewell is committed to a form of transcendental realism. According to Whewell, '*We have an* Intuition *of objects in space*; […] *and apprehend their spatial relations by the same act by which we apprehend the objects themselves*' (NOR, p.9).

Whewell may have regarded intuitions and concepts as ideas because he recognised that both were fundamentally active features of the mind within Kant's philosophy. Kant often describes the faculty of sensibility as a passive or receptive faculty in contrast to the faculty of the understanding which is active or spontaneous. However, it is a mistake to make this distinction between activity and passivity the essential difference between them. According to Watkins,

> sensibility is still active insofar as it does not literally receive representations from without, but rather actively forms representations […], if sensibility were essentially characterized solely in causal terms, then both sensibility and understanding would be active and would differ only by means of degree, contrary to Kant's position. (Watkins, 2017, p.24)

Whewell's philosophy is committed to the account that Watkins correctly explains is contrary to Kant's philosophy. This enabled Whewell to change the foundation of knowledge from the Kantian conception of knowledge as a product of intuitions and concepts. Instead Whewell argued it was a relation between thoughts and things. The underlying similarity between the philosophies of Kant and Whewell is that both regarded knowledge as the product of two irreducible elements, but Whewell's identification of both categories and intuitions with ideas or thoughts made it possible for him to locate the other irreducible source of knowledge in things. According to Whewell, '[i]n all cases, Knowledge implies a combination of Thoughts and Things. Without this combination, it would not be Knowledge. Without Thoughts, there could be no connexion; without

[39] In support of this interpretation is Whewell's response to Hume: '[o]ur inference from Hume's observation is, not the truth of his conclusion, but the falsehood of his premises;—not that, therefore, we can know nothing of natural connexion, but that, therefore, we have some other source of knowledge than experience' (PIS I p.75).

Things, there could be no reality' (PIS I p.18). Whewell termed this the fundamental antithesis and described it as 'the ultimate problem of all philosophy' (POD p.489).[40]

The problem that both Kant and Whewell faced was explaining how knowledge was the product of two irreducibly distinct sources. Whewell commented on the strange relationship that thoughts and things have with one another; from the perspective of knowledge they must be considered as united, but from the perspective of philosophy they must be considered as separate (PIS I p.18). Butts describes the relation between thoughts and things as susceptible to a version of the third man argument.[41] According to Butts, 'there must be some principle of unity that subsumes both terms in the pairs that Whewell lists. There must be some 'third man' (the problem is a variation on Kant's schematism problem)[42] which is like both Ideas and Things' (Butts, 1993, p.219).

The schematism is Kant's attempt to demonstrate the transcendental necessity of experience as the combination of both concepts and intuitions, whilst simultaneously conceding that knowledge of how this is achieved is beyond the discursive limits of cognition. This is one of the most obscure and difficult aspects of the First *Critique* (cf. Walsh, 1967, p.71). Kant admits the schematism is shrouded in mystery as he describes it as 'a hidden art in the depths of the human soul' (CPR A141/B180). It was crucial to Kant that the origin of experience emerges neither from some form of intellectual intuition (which he argued was a prevalent view amongst rationalist philosophers), nor from the direct experience of objects in themselves (which Kant attributed to empiricism). In the context of transcendental idealism, the schematism reinforced Kant's attack on rationalist metaphysics by appealing to the relation that pure concepts had to experience. According to Walsh, 'Kant's case against traditional metaphysicians […] is that having only the pure categories on which to build they succeed neither in saying anything precise nor in saying anything about anything in particular' (Walsh, 1967, p.85).[43] Whewell regarded this as a

[40] Whewell reproduced this in the appendix of POD; it was originally a letter written in 1844 to John Hershel as 'Remarks on a review of the philosophy of the inductive sciences'.

[41]The third man argument is originally a criticism of Plato's theory of forms in Plato's *Parmenidies* and Aristotle's *Metaphysics*. The argument is that the universal form from which particulars derive their properties must have some common property that is both like the universal and like the particular. Thus, it is necessary to posit a third entity that contains both these properties.

[42] For Kant, the role of the schema is to subsume intuitions under concepts. According to Kant, '[t]his mediating representation must be pure (without anything empirical) and yet **intellectual** on the one hand and **sensible** on the other. Such a representation is the **transcendental schema**' (CPR A138/B177).

[43]I discussed Kant's criticism of metaphysics in detail in the previous chapter and argued that it developed out of Hume's influence. See Chapter Two (2.2)

crucial limitation of Kant's philosophy because it restricted any possible knowledge to the structure of the pure categories.

The schematism simultaneously displays both Kant's ambitious rejection of transcendental realist metaphysics and the underlying humility of transcendental idealism. This humility consists in the idea that there is a limit to knowledge, experience, and explanation. This is not, as Langton suggests, 'a depressing discovery' because 'Kant thinks we are missing out on something in not knowing things as they are in themselves' (Langton, 1998, p.10). From a Kantian perspective it is difficult to understand how we could miss out on something that we are not warranted to posit knowledge of. For instance, in his response to the argument that the ideality of space and time reduces experience to mere illusions, Kant emphasises that the *a priority* of mathematics and geometry is only possible by understanding objects as appearances. He argues that if space and time lacked an *a priori* foundation then we could not rule out that our intuitions, or even geometry, are mere 'self-produced brain phantoms' or 'illusions' that do not correspond to any objects. Hence, Kant turns back the charge of experience as illusory against those who deny that space and time are conditions of experience rather than properties of objects in themselves. According to Kant, 'we have been able to demonstrate the incontestable validity of geometry with respect to all objects of the sensible world for the very reason that the latter are mere appearances' (P 4:292). Hence, the schematism provides additional support for Kant's rejection of space and time as properties of objects in themselves because it also emphasises that objects of experience are generated by the subject.[44] According to Gardner '[t]he obscurity attaching to the doctrine of schematism is the price which Kant ultimately pays for escaping from rationalism and empiricism, and rejecting the transcendental realist model of concept application' (Gardner, 1999, p.171).

Whewell does not share Kant's opposition to transcendental realism as he does not resolve the problem of the relation between thoughts and things by appealing to something analogous to Kant's schematism. I will return to Whewell's theological resolution of his account of the fundamental antithesis of thoughts and things once I have

[44]Thus, the schematism has an indirect relationship with the transcendental unity of apperception (cf. CPR A145/B185). The transcendental unity of apperception is "[t]he I think which must be able to accompany all my representations" (CPR B132). The significance of Kant's transcendental unity of apperception for the development of immunology is discussed in Chapter Five (3.2). It will be shown that the misunderstanding of Kant's conception of the self was crucial to the development of immunology.

outlined Whewell's philosophy of science. In this context, it is important to emphasise the structural similarity between their philosophies. Moreover, it was not Kant who was disappointed with the relegation of knowledge to appearances, but this was central to Whewell's dissatisfaction with Kant.

For Whewell, Kant could not develop an appropriate philosophy of science because Kant denied knowledge of things in themselves. According to Whewell, Kant made things in themselves 'a dim and unknown region. Things were acknowledged to *be* something in themselves, but *what*, the philosopher could not tell' (POD p.312). The implication of critical idealism was that it entailed that things in themselves can only be thought, yet never known. These entities necessarily remained beyond the domain of experience; 'appearances are […] given not in themselves, but only in this experience, because they are mere representations, which signify a real object only as perceptions' (CPR A494/B523).

Whewell's dissatisfaction with Kant's philosophy is further illustrated by his discussion of Kant's comparison of transcendental idealism with the Copernican revolution. The First *Critique* begins by proposing a transformation in our way of thinking that is at odds with sensory experience but is then demonstrated with apodictic certainty. Kant praised the Copernican revolution as an example of such a transformation (CPR Bxxii). Whewell argued that Kant's philosophy was in tension with the Copernican revolution as it had not sufficiently accounted for the conclusions drawn from it.

> Kant conceives that our experience is regulated by our own faculties, as the phenomena of the heavens are regulated by our own motions […], we may say that Kant, in explaining the phenomena of the heavens by means of the motions of the earth, has almost forgotten that the planets have their own proper motions, and has given us a system which hardly explains anything beside the broadest appearances. (POD p.313)

Kant had not merely forgotten that the planets have their own proper motions; critical idealism entailed that from the perspective of philosophy we must regard our knowledge of these motions as regulative (or reflective), rather than constitutive (or determinative). This distinction refers to the two possible forms of judgment in Kant's philosophy; '[t]he power of judgment is twofold, either *determinative* or *reflective*. The former proceeds from the *universal* to the *particular*, the latter from the *particular* to the *general*. The latter has only subjective validity' (JL §.81). Determinative judgments are governed by the twelve pure categories that are necessary for the possibility of experience. They

'provide the appearances with their lawfulness and by that very means make experience possible' (CPR A126). The primary function of the faculty of the understanding is not to establish scientific laws which build on the content of experience. Rather the pure categories are rules that are necessary for the possibility of experience. Kant describes them as an exhaustive 'listing of all original pure concepts of synthesis that the understanding contains in itself *a priori*' (CPR A80/B106).

The dissimilarity between the Kantian and Copernican revolutions is that for the former science is an enquiry into the systematising capacity of the subject to project an order onto nature, whereas the latter had sought to discover the laws of nature that persist independently of the subject. In a similar line of argument, Meillassoux charged Kant's analogy to the Copernican revolution with committing a violent contradiction. Kant's reorientation of scientific knowledge from a realism pertaining to truths that are independent of experience, to an idealism which re-established the subject at the centre of knowledge, has been described as returning to an essentially Ptolemaic conception of science. According to Meillassoux, Kant's philosophy is more appropriately described as the Ptolemaic counter-revolution as 'it is only since philosophy has attempted to think rigorously the revolution in the realm of knowledge brought about by the advent of modern science that philosophy has renounced the very thing that constituted the essence of this revolution' (Meillassoux, 2008, p.118). The essence of the revolution of modern science was its ability to go beyond phenomena by utilising mathematics to establish knowledge about objects independent of experience.

Whewell does not explicitly identify Kant's philosophy with the Ptolemaic scheme; yet the similarity between his descriptions of both is striking. He describes the Ptolemaic scheme as 'the view of those who appeal to phenomena alone as the source of our knowledge, and say that the sun, the moon, and the planets move as we see them move, and that all further theory is imaginary and fantastical' (POD p.314). Central to both is the appeal to phenomena as the source of knowledge and the inability to extend the same level of certainty for the celestial motions of the objects in themselves.[45]

[45] Whewell did not share Meillassoux's criticism of Kant as he commended Kant for revealing that knowledge necessarily required phenomena, whereas Meilassoux regarded the limitation to phenomena as the essential problem of transcendental idealism. Meillassoux is primarily concerned with demonstrating that Kant's philosophy requires absolute knowledge that goes beyond critical idealism. In short, he argues that the contingency inherent in all experiences, which applies to both entities which remain the same or change at every moment, is the only positive absolute truth that is necessary and eternal. In other words,

This reveals why Whewell may have avoided committing himself to Kant's transcendental framework. He recognised that Kant's philosophy was implicitly committed to the renunciation of the scientific developments that it had appealed to in support of the revolutionary shift toward transcendental idealism. Kant could not provide an adequate account of how the metaphysical foundations of natural science could elaborate empirical principles of physics.[46] For Kant, knowledge of scientific laws required that the empirical concept corresponding to an intuition is given *a priori* (MF 4:470). In the *Metaphysical Foundations of Natural Science,* Kant identified the empirical concept of matter as a case where this is achieved because the experience of matter is inseparable from the *a priori* intuitions of space and time. This sufficiently demonstrates the conditions for the empirical concept of matter as a particular law for every possible experience of outer sense. According to Kreines, the empirical concept of matter is a special case which has achieved this synthetic *a priori* necessity; however, more generally 'we can clearly see that Kant is right to rule out the possibility of similar derivations for particular laws' (Kreines, 2008, p.540). That is, Kant is right in the context of his critical philosophy which argues that our inability to establish *a priori* principles for particular laws is not a result of deficient scientific knowledge at any point in time. Rather 'the limit is *in principle* and ineliminable; our lack of knowledge stems not from the state of science at some particular time but from our limited access to *a priori* intuition, or from "the limits of our faculties of cognition"' (Kreines, 2008, p.541).[47]

In contrast, Whewell attributed to objects in themselves the power to *inform* ideas which are employed for a scientific understanding of nature. Thus, he opposed Kant's view that pure intuitions and pure categories formed an exhaustive account of the possible conditions of knowledge. According to Fisch, Whewell 'rejected Kant's claim that the list of the two forms of intuition and the categories discernable through their role in former knowledge, exhausts the range of possible categories of any future knowledge' (Fisch, 1985, p.292). Fisch interprets this as supporting his argument that Kant was minimally influential on the development of Whewell's philosophy of science. Fisch argues that

'[t]he absolute is the absolute impossibility of a necessary being' (Meillassoux, 2008, p.60), or the necessity of contingency.

[46]Ducheyne argues that the late Kant came to realise this issue and addressed it in the unpublished *Opus Postumum* as the *Metaphysical Foundations of Natural Science* isolated metaphysics from physics (Ducheyne, 2012, p.26). Ducheyne describes the relation between metaphysics and physics as the 'bridging problem' and argues this was source of Whewell's dissatisfaction with Kant's philosophy.

[47] In this context, Kreines is opposing Freidman's suggestion that we have not yet discovered such particular laws to be indications that such laws could in principle be discovered.

neither in Whewell's published nor unpublished works during the early 1830's, when Whewell was developing his philosophy and epistemology of science, did he reference Kant. There were 'no questions of epistemology, of the possible boundaries of human knowledge […] no categories, no forms of intuition, no talk of analytic versus synthetic a priori truths' (Fisch, 1991, p.105).[48] In opposition, Ducheyne has identified various references to Kant's philosophy in Whewell's unpublished notebooks written during this period (between approximately 1830-1833). For instance, Whewell described space and time as intuitions and explicitly appealed to Kant's term '*Anschauung*' (Ducheyne, 2010, p.258).[49] *Pace* Fisch, Whewell's lack of reference to Kant's philosophy during the development of his philosophy of science should be understood in the context of Whewell's dissatisfaction with transcendental idealism. Whewell did not engage in the problems specific to Kant's critical philosophy because it relegated things in themselves to an unknown X.[50]

In summary, Kant influenced Whewell's conception of knowledge as constituted by a fundamental antithesis, yet Whewell was critical of the implications that transcendental idealism had for the possibility of scientific knowledge. Hence Whewell diverged from the conception of knowledge as a joint product of concepts and intuitions, instead he argued that the fundamental antithesis was between ideas and objects in themselves. The similarity in the structure of their philosophies was demonstrated by examining Butt's argument that both Kant and Whewell were committed to different variations of the 'third man argument'. I considered Whewell's comments on Kant's Copernican revolution as illuminating Whewell's dissatisfaction with Kant's philosophy.

2. Whewell's colligation of facts and the consilience of inductions

The antithesis between thoughts and things enabled Whewell's philosophy of science to develop in a different direction than could be permitted by a Kantian philosophy of science. Whewell moved from the antithesis between thoughts and things to the antithesis between facts and theories. According to Whewell, 'a Fact is a combination of our

[48] For a similar account (cf. Snyder, 2006, p.46)

[49] Another reason why Whewell might not have adopted Kantian terminology in his published works was because of the negative reception of Kant's philosophy in the British Isles at this time (Cf. Ducheyne, 2010, p.255; Fisch, 1991, p.105).

[50] Kant describes the thing in itself as an X that is 'nothing for us' (CPR A105). Whewell adopted this position in his unpublished notebooks as early as 1832 (Ducheyne, 2011).

thoughts and things in so complete agreement that we do not regard them as separate' (PIS I p.24). In contrast, a theory is distinct from facts, yet not independent of them. A theory is an idea that goes beyond what is currently known as fact which has the potential to become true knowledge if it can effectively colligate facts. According to Butts, '[t]o get science, we need ideas that are clear and distinct, and that adequately colligate facts in such fashion that general propositions about matters of fact become possible' (Butts, 1993, p.193). Whewell describes the colligation of facts as the process by which scientists form testable hypothesis that have the potential to combine 'scattered facts into a single rule' (PIS II p.41). This does not mean that every hypothesis will adequately colligate facts, it merely entails that the colligation of facts is a requirement for science. The ability of scientists to produce clear and distinct ideas which bind facts together under a general rule cannot be taught in accordance with any pre-existing rule. According to Whewell, 'it more frequently happens that new truths are brought into view by the application of new Ideas, not by new modifications of old ones' (NOR p.66). Hence, this capacity belongs to the sagacity or wisdom of particular discoverers.

The colligation of facts is similar to Kant's account of the regulative unity of science in some important respects. For both, establishing unity is not merely an enumeration of examples as this could not justify the necessity that such principles hold in all cases. In contrast to Kant, Whewell maintains that such principles are not merely regulative principles of reason, but evidence for the truth of a theory. For any successful colligation of facts, a clear and distinct idea is superinduced via means of a hypothesis not merely on the current facts belonging to a class, but any future phenomena belonging to that same class. Hence, a colligation of facts should accurately predict future facts of the same class where the hypothesis would apply. According to Whewell, '[t]he prediction of results, even of the same kind as those which have been observed, in new cases, is a proof of real success in our inductive processes' (PIS II p.65).

The greatest evidential force of the correctness of a theory is achieved when a hypothesis can be applied to cases involving a class of facts that differs from the original class the hypothesis explained. According to Whewell, '[t]hat rules springing from remote and unconnected quarters should thus leap to the same point, can only arise from *that* being the point where truth resides' (ibid). Whewell terms this 'jumping together' of facts belonging to different classes under a single rule 'the consilience of inductions'.

Whewell's justification for the principle of consilience is both historical and philosophical. In the historical context, he argues that there has been no occasion in the history of science where a theory has achieved consilience and has later been proven false (POD p.275). One example that Whewell discusses is the discovery of universal gravitation; not only did it explain the perturbations of planets in relation to each other and to the sun, but it also explained axial precession. Whewell describes the ability for the theory to explain this coincidence as giving the theory 'a stamp of truth'.

Whewell's Kantian influence has been emphasised by Butts: 'Whewellian consilience is the prodigy of Kantian systematization' (Butts, 1994, p.280). Whilst there are significant similarities between Kant and Whewell in relation to their accounts of the systematisation of nature, there are also equally significant differences. Recall that for Kant, most scientific laws are denied the possibility of being known with *a priori* certainty. Despite this lack of knowledge, such laws can nonetheless be used as regulative principles that guide scientific enquiry. Kant describes how the principle of gravitation is utilised to explain the motions of the planets and comets. Such principles can be followed

> merely by approximation, without ever reaching them, yet these principles, as synthetic propositions *a priori*, nevertheless have objective but indeterminate validity, and serve as a rule of possible experience, and can even be used with good success, as heuristic principles, in actually elaborating it; and yet one cannot bring about a transcendental deduction of them (CPR A663/B691)

A transcendental deduction is not possible for these principles because they are not necessary conditions for the possibility of experience, but only necessary conditions for the possibility of science. They are heuristic principles, but this does not entail that their deployment is anything less than law governed. They impose a systematic unity and completeness on nature which cannot be derived from intuitions and concepts. Rather reason subsumes the relevant experiences under a general rule. Reason projects a complete unity and order onto nature. According to Kant, this 'completeness can […] only be understood as a completeness of principles, but not of intuitions and objects' (P 4:332). Therefore, it is not possible to regard this unity as derived from our experience of nature, nor does it pertain to any object independent of experience.

According to Allison, the connotations attached to the term 'heuristic' are misleading as a description of these regulative principles. He draws on Kant's dictum that 'reason does not beg but commands' (CPR A653/B681) unity. According to Allison, 'to

deny that reason begs is to deny this principle is a merely heuristic device through which it approaches nature, hat in hand, as it were, hoping to find some degree of confirmation' (Allison, 2008, p.143). To be clear, insofar as regulative principles are deployed by the subject they are appropriately described as heuristic principles. Unlike heuristic principles, regulative principles are neither a matter of choice nor chance, but a precondition for the possibility of scientific enquiry.

This marks a significant difference between the philosophies of Kant and Whewell, the former is concerned with demonstrating the boundaries of knowledge which has significant limitations for scientific knowledge. In contrast, Whewell was not concerned with restricting the domain of scientific knowledge, instead he intended to develop a philosophical methodology that was appropriate *for* science (Fisch, 1985, p.309). He was motivated to supplement the scientific methodology of his time with a philosophy that supported the development of science. He recognised the limitations of transcendental idealism insofar as it denied theoretical knowledge of objects in themselves and reduced this domain of knowledge to intuitions and concepts. Whewell did not adopt the terminology specific to transcendental idealism because he wanted to avoid committing himself to the limitations he exposed within Kant's philosophy. This does not mean that Kant did not influence Whewell; he was influenced by Kant's emphasis on the active powers of the mind, knowledge as formed from two irreducible elements, and the demand for a unified science. Contrary to Kant, Whewell emphasised the wisdom and sagacity of scientists in discovering new theories, and the ability to test objects in themselves for potential confirmation of these theories. According to Whewell,

> Not only do I hold that the Axioms, on which the truths of science rest, grow from guesses into Axioms in various ways, and often gradually, and at different periods in different minds […]; but I conceive that this may be shown by the history of science, as having really happened, with regard to all the most conspicuous of such principles. (POD p.344)

Only by considering the history of science could it be shown that this was already the process by which scientific truth had previously been derived. He sought to dissolve the difference in kind that Kant had established between constitutive and regulative judgments by demonstrating that in the progress of science '*a posteriori* truths become *a priori* truths' (POD pp.357-8).

This appeal to the history of science as justification for the correctness of his philosophy of science is problematic. From the perspective of transcendental idealism

this could only secure the fact that the structure of Whewell's philosophy of science is compatible with the history of science on a factual basis, but this does not demonstrate the warrant of Whewell's claim that he has established the procedure for scientific theories to discover correct explanations which culminate in a progressive science. Whewell's account of scientific knowledge was also supported by his appeal to theology.

3. Whewell's theological resolution of the fundamental antithesis

This section compares Whewell's theological resolution of the fundamental antithesis with Kant's refutation of the ontological argument. In this context, Kant's refutation of the ontological argument is significant not merely as a refutation of Whewell's supporting argument for his belief in the existence of God, but as a refutation of the basis of Whewell's justification for his philosophy of science.

The prevalent explanation for Whewell's resolution of the fundamental antithesis is his appeal to theology. According to Whewell, 'our Ideas correspond to the Facts of the world, and the Facts to our Ideas, because our ideas are given us by the same power which made the world, and given so that these can and must agree with the world so made' (POD pp.358-9). This does not mean that our scientific knowledge is equivalent to God's knowledge. Whewell appeals to the humility of our own scientific knowledge in comparison to the ideas in the divine mind. The latter 'sees the essence of things through all time and through all space; while we, slowly and painfully, by observation and experiment […], make out a few of the properties of a kind of thing' (POD pp.367-8).

The theological resolution establishes the basis for our warrant to consider properties as necessarily belonging to kinds because objects appear to the divine mind in their essence, the properties of which are necessary consequences. Whewell denies that we could arrive at knowledge of the world as the divine mind conceives it. He appeals to metaphors of the ocean to elucidate the difference in the magnitude of knowledge of the divine mind in comparison to our own. He describes our science as a drop in the ocean of what is known to the divine mind (ibid), and our science extends only so far as it keeps its footing 'in the shallow waters which lie on the shore of the vast ocean of unfathomable truth' (POD p.371).

This reveals the dual aspects of extravagance and humility within Whewell's philosophy that are reversed in Kant. Whewell's account is extravagant insofar as the claim that necessity can be inferred from the necessity of the divine mind is essentially the dismissal of Hume's problem of induction. Whewell suggested that what Hume revealed was that necessity must be derived from a source other than experience, rather than demonstrating that it lacks any rational ground. Whewell saved knowledge of necessary connections between objects in themselves at the cost of sufficiently resolving these two distinct sources of knowledge. Alternatively, Kant limited his conception of necessity to the domain of possible experience at the cost of making objects independent of our experience completely inaccessible to experience. According to Kant, '[t]he non-sensible cause of these representations is entirely unknown to us, and therefore we cannot intuit it as an object' (CPR A494/B522). Hence, Kant rejected any possibility that appearances could relate to knowledge of objects in themselves, as both the properties and origin of such objects is entirely unknown to us.

In relation to knowledge of the existence of God, Kant famously exposed the problematic status of the ontological proof of God's existence. He argued that being 'is obviously not a real predicate, i.e., a concept of something that could add to the concept of a thing' (CPR A598/B626). The statement "God exists" can be understood as either an analytic or synthetic statement. Kant argues that if it is meant analytically, then it is tautological because the predicate of existence would be contained in the subject of God. In contrast, if the statement is meant synthetically, then it would be impossible to conceive of the possibility that the predicate could be false without contradiction. The existence of God would already be demonstrated if God was an empirical object. According to Kant, '[i]f the issue were an object of sense, then I could not confuse the existence of a thing with the mere concept of a thing' (CPR A600/B628). The appropriate domain for the deployment of concepts is always empirical. In cases where there is no corresponding experience and we attempt to 'think existence through the pure category alone […] it is no wonder that we cannot assign any mark distinguishing it from mere possibility' (CPR A601/B629). Hence, Whewell's argument that God has complete knowledge of our ideas, whereas we only have a limited knowledge, is not warranted from the perspective of transcendental idealism. This argument would require us to demonstrate the existence of God which Kant argues is beyond the possibility of knowledge. Hence, Kant would

oppose Whewell on the basis that reason, not God, is the source of our ideas. According to Kant,

> [A]ll the questions that pure reason lays before us, lie not in experience but themselves in turn only in reason, and they must therefore be able to be solved […], since reason has given birth to these ideas from its womb alone, and is therefore liable to give an account of either their validity or their dialectical illusion. (CPR A763/B791)

This does not mean that we view the world from a God's eye view; rather we deny the legitimacy of considering our own reason as a deficient form of God's reason. Insofar as the conditions for knowledge of God's existence are beyond the possibility of experience, God is a regulative principle. According to Kant, 'reason's supposition of a highest being as the supreme cause is thought merely relatively, on behalf of the systematic world of sense, and it is a mere Something in the idea, of which we have no concept of what it is **in itself**' (CPR A679/B707).

Whewell's need to appeal to God to resolve the fundamental antithesis—which is central to his justification for his philosophy of science—is significant because it reveals his need to ground the unity of nature in something other than our own rational capacity. Not only is this attempt to justify his philosophy of science theologically insufficient from the perspective of transcendental idealism, it has important implications for both contemporary interpretations of Kant's philosophy that attempt to make Kant's philosophy compatible with (or supportive for) contemporary philosophy of science and contemporary philosophies of science that continue to appeal to consilience.

2. The status of consilience in contemporary philosophy of biology

This section examines contemporary appeals to the principle of the unity of science. First, I consider contemporary interpretations of Kant which suggest he can offer support to philosophy of science. The two accounts discussed are Kitcher's appeal to the historical inheritance of scientific theories and Breitenbach's and Choi's conception of unified pluralism. I argue that neither account adequately identifies the implications of Kant's account of scientific laws as regulative principles. Second, I examine appeals to consilience in contemporary philosophy of science. I consider the role of consilience in arguments for biological reductivism from Mackie and Wilson. Both place a greater

demand on consilience than Whewell's original formulation. Whewell's account of consilience was originally a methodological principle that was not a universal demand on nature but rather a context specific proof of a theory. In contrast, they argue that a universal principle of consilience demands that all human action can be explained in accordance with biological reductivism.

1. Contemporary interpretations of Kant's philosophy of science

The distinction in kind between constitutive and regulative principles in Kant's philosophy has significant implications for the potential historical justification of scientific theories. This has not been adequately addressed in some interpretations of Kant that suggest he can offer support for contemporary philosophy of science. Kitcher proposes a broadly Kantian account of science that appeals to the historical indebtedness of scientific practices. He aims to purge Kant's philosophy of its commitment to *a priori* elements. There are many aspects of Kant's philosophy where *a priori* conditions are offered as the basis for justification, so it is important to understand precisely which aspects of Kant's *a priority* Kitcher's account is rejecting. Kitcher opposes the demand for *a priori* certainty that is central to Kant's distinction between proper and improper sciences on the basis that the former 'treats its object wholly in accordance to a priori principles' (MF 4:468). Kitcher emphasises that the regulative status of scientific enquiry seems to be at odds with the stringent demand that Kant places on science. The relation between rationality and science is minimally 'choosing the better over the worse, or, in the actual conduct of science, selecting the best of the options that have been explicitly formulated' (Kitcher, 1986, p.229). For Kitcher, science is inseparable from history as we inherit our ideas of science from our predecessors.

> We do not go through any explicit process of systematizing our beliefs and attempting to maximize the unity of the system. We absorb from our predecessors the order of nature that they have projected, so that, from the beginning of our own discussions of the world of experience, we tacitly operate with claims about causal dependencies and natural kinds that have been generated by the systems of our ancestors. Our justifications are thus parasitic on the history of attempts to construct a systematic unification of human experience. (Kitcher, 1986, p.222)

Kitcher does not sufficiently account for the inherent difficulty in the projection of the unity of nature understood merely as a regulative principle. Our warrant for claiming to inherit these systematic accounts of nature from our predecessors must first require that

they are compatible with the conditions of Kant's critical philosophy. Critical idealism imposed strict boundaries on the appropriate domain of scientific enquiry. Kant described the First *Critique* as a ground clearing exercise (CPR Axxi) because it identified the limits of knowledge and recognised 'that human reason has the propensity to overstep all these boundaries' (CPR A642/B670). The unity of nature is one example of how reason oversteps the boundaries of knowledge, but this is warranted when the unity of nature is recognised as a regulative principle. The transcendental ground of the regulative principle of the unity of nature is an analogue to the structure of the schema. The schema describes how the understanding subsumes intuitions under concepts to produce experience; by analogy, reason projects the rules of the understanding to produce an undetermined unity. According to Kant, '[t]he actions of the understanding, however, apart from the schemata of sensibility, are **undetermined**; likewise the **unity of reason** is also in itself **undetermined**' (CPR A665/B693).[51]

The unity of reason treats the rules of understanding as objects, but they cannot be objects in the strict sense because objects are given to experience via intuitions. Thus, the regulative principle of unity is *a priori*, necessary and objective, yet it cannot determine either objects or the scope of reason. According to Allison, Kant's appeal to the illusion of the *focus imaginarius* reveals how Kant regarded the unity of nature as indispensable, yet fictitious (cf. Allison, 2004, p.430). The *focus imaginarius* relates to an optical illusion whereby an image in a mirror is believed to relate to an object behind the mirror. In its empirical context the illusion is optical, in its rational context the illusion is transcendental. For both cases, the illusion does not reside in its presentation, but from what is inferred from that presentation. For Kant, we are warranted in viewing nature as unified insofar as we recognise that the justification for seeking that which lies outside of the field of possible empirical cognition is projected rationally, rather than being derived from some unknown supersensible object.

This interpretation significantly differs from that offered by Kitcher. The conception of science as guided by the regulative unity of reason can only distinguish between better and worse scientific theories in a limited capacity. It could distinguish between warranted and unwarranted theories insofar as any scientific theory that claims knowledge of objects in themselves would not be permitted in accordance with

[51] This was discussed in Chapter Three (1.1).

transcendental idealism. Such theories would be committed to a version of transcendental realism. Moreover, it would be impossible to rank multiple theories that were compatible with transcendental idealism. Any compatible theory would necessarily endorse the account of scientific unity as an indispensable and indeterminate product of reason that cannot correspond to, or be sufficiently demonstrated by, any empirical object. These theories would develop in accordance with reason which cannot be in antithesis or contradiction with itself (CPR A740-7/B768-75). Kitcher's account of judging the best scientific theory by selecting from available alternatives is closer to Whewell's appeal to the history of science as justification for his account of the consilience of inductions. For both, these historical appeals are results of their denial of transcendental idealism, specifically claims that the development of scientific theories should be grounded on *a priori* principles. Reason cannot resolve disputes between alternative accounts of science, instead it is 'set the task of determining and judging what is lawful in reason in general' (CPR A751/B779).

Another account that has suggested that philosophy of science could benefit from adopting a Kantian spirited methodology is Breitenbach's and Choi's account of 'unified pluralism'. In contrast to Kitcher's argument that focuses on the historical development of science, they consider the rise of pluralism that suggests that many different research methods can be deployed simultaneously to gain a more accurate scientific understanding. They note that the conception of science as pluralistic, rather than unified, has become widespread. Moreover, they support aspects of the pluralist methodology insofar as it aims to approach nature from a variety of different methodologies. However, they argue that pluralism alone is not sufficient if scientific practitioners following different methodologies are not working in communication and collaboration with one another. According to Breitenbach and Choi, '[a]dopting different approaches is beneficial only if the individuals are communicating and cooperating enough that it can be said that they are together trying to solve the problem using a plurality of approaches' (Breitenbach and Choi, 2017, p.396).

Unified pluralism does not defend any pre-established notion of the unity of science, but simply opposes the tendency of pluralist methodologies to deny the possibility that science could be unified. Breitenbach and Choi argue that these methodologies do not consider the importance of communication and cooperation which results in an inability to recognise the possible ways that nature could be unified. In

contrast, unified pluralism aims to preserve the ideal of the unity of science without presupposing its specific form prior to scientific evidence. In principle, this unity could comprise a single homogenous reductive account of science, or a systematic collection of heterogeneous laws, but 'each of these parts would have to, in virtue of its heterogeneity, play a unique, necessary and specifiable role in contributing to our unified understanding' (Breitenbach and Choi, 2017, pp.398-9).

The motivation to preserve a methodology of science that does not reject the possibility of discovering a unified science is commendable, yet Breitenbach's and Choi's account is problematic for reasons similar to those raised against Kitcher. Like Kitcher, they overlook the fact that some of the contemporary methodologies of science might not be compatible with Kant's critical philosophy. Transcendental idealism gives philosophy the judicial role of identifying the conditions under which claims of scientific knowledge that are warranted can be distinguished from those that are not. According to Breitenbach and Choi, this responsibility falls to the scientific practitioners and philosophers of science themselves:

> We assume the results of different inquiries can be compared and contrasted with one another in order to add to a better understanding of the same natural world, understanding that, if it *could* be completed, would be an understanding of the natural world as a whole. Aiming to unify our theoretical insights in this way is, we suggest, what it means to regard the pluralist unity of science as a regulative ideal.
>
> (Breitenbach and Choi, 2017, p.401)

The problem is that many disagreements within the philosophy of science arise because of differences that Kant would argue are irresolvable as they emerge from commitments to unwarranted transcendental realist principles. For Kant, we must be sure that disagreements which arise are based on disputes that can in principle be resolved; the strict regulation of the boundaries of knowledge is Kant's attempt to secure this principle. The tendency for philosophers of science to adhere to metaphysical principles that cannot be sufficiently justified in accordance with transcendental idealism is a barrier to the communicative and cooperative account of science Breitenbach and Choi advocate. The success of securing such behaviour across scientific methodologies requires that philosophers of science and scientific practitioners first agree on both the problem their diverse methodologies are aimed at resolving and the appropriate boundaries that scientific enquiry should adopt to promote a cooperative approach to science.

For example, consider the philosophies of scientific method developed by Kuhn, Lakatos, and Feyerabend discussed in Chapter One. These accounts explained how scientific theories have various inbuilt mechanisms which are directed toward their own self-preservation.[52] This suggests that unified pluralism allows for the possibility of a unified account of science to develop, but in practice the methodologies of science may have inbuilt mechanisms that raise potential difficulties for realising this unity. To ensure the development of science promotes cooperation and communication, it would be necessary to provide a framework that establishes the proper domain of warrant for scientific enquiry. For instance, Kant emphasised that speculative disputes between transcendental realists were essentially irresolvable because they did not relate to any possible experience. According to Kant,

> how can two people conduct a dispute about a matter the reality of which neither of them can exhibit in an actual or even in a merely possible experience, about the idea of which he only broods in order to bring forth from it something **more** than an idea, namely the actuality of the object itself? (CPR A750/B778)

This does not mean that all disputes between differing accounts of science will relate to objects that cannot be exhibited in actual or possible experience, but without the broader commitment to transcendental idealism it is difficult to understand how alternative conceptions of sciences could defend themselves against the potential of this arising.

For instance, this approach to the unity of science could accommodate either Bhaskar's or Cartwright's philosophies of science discussed in the previous chapter.[53] Neither Bhaskar nor Cartwright opposed the idea of the unity of science; however, they proposed alternative accounts with regard to how this unity could be conceived. For Bhaskar, the possibility of science required that we presuppose the existence of intransitive transfactual laws that are uniform across reality, whereas scientific experimentation can only investigate these laws in their transitive context. Nature does not demonstrate law-like regularity at the empirical level, but this does not entail that nature in itself is not governed by intransitive laws. In contrast, Cartwright argued that there is no empirical justification for the belief in universal regular laws. She argued that laws should be understood as context-specific relating to the experimental conditions or

[52]These included rewriting scientific textbooks after each 'paradigm shift' or directing future research toward auxiliary hypothesis rather the hard-core elements of scientific theory that would entail the refutation of the theory as a whole. See Chapter One (2-4).
[53] See Chapter Two (3)

nomological machines that establish local regularity by assembling causal capacities in a particular way. Transcendental idealism can offer a resolution to these accounts because it reveals how their incompatible appeals to the metaphysical structure of science presuppose that the conditions of objects in themselves can be derived from knowledge of the appearance of objects. Both agree that laws do not express uniform law-like regularity at the level of appearance, yet they disagree about the implications this has for the metaphysical status of laws. Transcendental idealism preserves the unity of science as a regulative ideal without demanding that this unity is an ontological condition of objects independent of experience. The cost of this resolution is that philosophers of science must concede that they lack justification for deriving metaphysical claims regarding the status of laws from appearances.

In summary, the support that Kant can offer contemporary philosophy of science comes at a cost. For Kitcher, it requires that the aspects of Kant's transcendental idealism which are incompatible with contemporary philosophy of science—such as his commitment to *a priority*—are replaced with an appeal to the current scientific theories available to us. In contrast, Breitenbach and Choi argue that Kant's account of regulative unity would help direct scientific research toward communicative and collaborative ends. This entails that scientific practice must be consistent with the broader tenets of transcendental idealism which offer justification of how the regulative unity of science is both an indispensable and non-ontological principle.

2. Consilience in contemporary philosophy of biology

This final section explores how consilience has been deployed in contemporary philosophy of biology. I consider the recent arguments for the reduction of ethics to scientific biological explanations. These contemporary accounts of consilience significantly differ from Whewell's original formulation which appealed to consilience as something essentially unexpected. In contrast, contemporary accounts of consilience tend to appeal to a metaphysical demand for the unity of science that is detached from empirical justification.

Mackie criticised the notion of objective values in his well-known argument from queerness. According to Mackie, any moral theory committed to an account of objective values requires that such values are simultaneously objective and prescriptive. He argues

that if such entities were to exist they would be 'utterly different from anything else in the universe' and we would require 'some special faculty of moral perception or intuition, utterly different from our ordinary ways of knowing' (Mackie, 1977, p.38). In this context, it is not the argument from queerness that is of primary interest, but Mackie's alternative biological explanation for moral behaviour.

Mackie aligns himself to empiricism as he argues that experience provides direct access to the physical world. Our 'ordinary way of knowing' entails that we have objective knowledge of the content of experience. The argument from queerness is not directed against non-objective moral prescriptions; '[w]e all have moral feelings […] which we therefore try to encourage and develop or to oppose' (Mackie, 1946, p.77). The reason for associating Mackie with the principle of consilience is his faith in biology as providing an explanation of morality on the basis of evolutionary pressures. According to Mackie,

> [T]he ordinary evolutionary pressures, the differential survival of groups in which such sentiments are stronger, either as inherited psychological tendencies or as socially maintained traditions, will help to explain why such sentiments become strong and widespread.
>
> (Mackie, 1977, p.113)

The investigation of moral behaviour as originating from biological processes is most widely associated with Wilson's *Sociobiology*. Wilson describes his account as taking morality from the hands of philosophers and approaching it from the perspective of biology (Wilson, 1975, p.287). For him, the difference between the philosophical and biological approaches toward morality concerns the way that each regards its origin. Philosophy has approached the brain 'as though that organ must be treated as a black box' (ibid). Wilson argues this has led philosophy to generally adopt a transcendental[54] perspective on ethics which regards morality as existing outside of nature, whereas the biologists adopt an empiricist perspective on morality as emerging from evolutionary pressures. According to Wilson, '[c]ausal explanations of brain activity and evolution, while imperfect, already cover the most facts known about moral behavior with the greatest accuracy and the smallest number of freestanding assumptions' (Wilson, 1998, p.268). For Wilson, the discovery of the biological foundations of ethics would reconcile

[54]This transcendental perspective does not seem to be limited to Kant's critical philosophy. Rather Wilson seems to regard this term as inclusive of any philosophical approach that does not recognise the importance of biological pressures.

the division between the humanities and sciences and contribute toward a universal consilience of nature.

The principle of consilience is central to Wilson's argument; however, his account differs significantly from Whewell's original formulation. Wilson's application of consilience supports an ontologically reductionist account of science. He emphasises that biology will offer an account of morality that is reducible to evolutionary principles. Wilson argues that if this biological explanation of ethics fails, then the possibility of a universal consilience also fails. According to Wilson, 'if evidence contradicts empiricism in any part, universal consilience fails and the division between science and humanities will remain permanent all the way to their foundations' (Wilson, 1998, p.288). In contrast, Whewell's appeal to consilience as an unexpected consequence is crucial for understanding its explanatory power. According to Whewell, '[w]hen principles in some instances have proved sufficient to give an unexpected explanation of facts, the delighted reader is content to accept as true all other deductions from the principle' (POD p.164). *Pace* Wilson, this does not entail that any single theory must explain every kind of fact. Nor does it entail that if consilience is not achieved in a particular case, then it could not be achieved in a different case. If a biological explanation of morality is impossible, then biological explanations might still achieve consilience when applied to other kinds of facts.

Wilson's expectation of a biological explanation of morality could not be greater; the possibility of consilience depends on a biological explanation of ethics. Wilson regards consilience as the method and metaphysics by which science discovers the single unified ontological foundations of the laws of nature. The belief in consilience is metaphysical insofar as it is grounded on the adverse consequences which would arise for science if reality did not manifest consilience at an ontological level. In contrast, Whewell understands consilience primarily as a methodological procedure. It is not the metaphysical presupposition of a reductive science, but rather a methodology for testing hypotheses. Laudan explains that this has tended to be overlooked by Whewell scholarship at the cost of significantly misinterpreting his account. According to Laudan,

> Whewell's aim in stressing the consilience of inductions is not to maximize content, but to maximize the confirmation of an hypothesis. Of course, Whewell did believe that in the progressive growth of science, we advance towards theories of greater scope, range and generality. But (and this is crucial) increased generality is only a gain insofar as that greater generality is experimentally confirmed.

> Consilience is, effectively, a criterion of acceptability which stipulates that those hypotheses are most worthy of belief and acceptance which pass empirical tests. (Laudan, 1971, p.372)

The increase of knowledge is a by-product of consilience. The primary effect of consilience is to demonstrate the correctness of a theory because it can be applied to a different case. In this sense, the theory that consilience primarily supports is the theory that is being applied to a new set of facts, rather than the set of facts it is being applied to. For instance, if a biological explanation can be applied to facts belonging to a different kind, it increases the likelihood that the biological explanation is correct.

The difference between consilience in its reductive metaphysical and Whewellian forms is that the former is grounded in speculation rather than empiricism. According to Dupré, metaphysical assumptions about the unity of nature 'are not the most plausible explanations, and certainly not the responses that should appeal to a committed empiricism' (Dupré, 2012, p.30). Dupré regards such an account as inconsistent with his conception of biology as consisting of ontological processes. Of course, this process ontology is also a metaphysical, rather than an empirical hypothesis. Dupré argues that the distinction between metaphysics and epistemology is not one of kind but rather one of degree. 'If it turns out that process is indeed the right concept to make sense of nature, then this is as good a reason as we can expect for taking nature to be ontologically composed of process' (Dupré & Nicholson, 2018, p.4).

This is relevant to the discussion of the possible compatibility of Kant's philosophy with contemporary philosophy of science. This dispute between ontological reductivism and processualism in this context is a debate that goes beyond empirical confirmation; it is between alternative versions of transcendental realism. This does not mean that Kant's critical philosophy cannot be potentially beneficial for contemporary philosophy of science, but it would require these philosophers to re-examine the relationship between metaphysics and epistemology.

Conclusion

This chapter has shown that Kant's account of the active powers of the mind, knowledge as derived from two irreducible sources, and the unity of science were all influential on Whewell's philosophy of science. I argued that Whewell's deviation from transcendental idealism was due to his dissatisfaction with the implications of transcendental idealism

for scientific knowledge. Whewell's divergence from Kant led him to develop his account of the colligation of facts and consilience of inductions which I will argue influenced the development of Darwin's theory of natural selection. Whewell argued that scientific knowledge related directly to objects in themselves, rather than the mere appearance of objects. This entailed that Whewell needed to explain how the consilience of inductions corresponded to the world in itself and was not limited to a regulative rational principle. Whewell appealed to the history of science to show that there had never been a case where consilience of inductions had been achieved and later proven false. He also appealed to theology to resolve difficulties pertaining to the fundamental antithesis and consilience of inductions. I argued that transcendental idealism could critically respond to Whewell's appeal to theology both as a justification for the existence of God and in relation to the broader implications this had for Whewell's philosophy of science.

Section two discussed interpretations of Kant that argue in support of the potential benefits of Kant's philosophy for contemporary philosophy of science. First, Kitcher's account of science as derived from the best available theories was examined. I argued that Kant's critical philosophy is not suitable for Kitcher's account because reason could only distinguish theories that are warranted in accordance with transcendental idealism from those that are unwarranted. For Kant, it is not possible for multiple theories that are consistent with transcendental idealism to offer conflicting accounts as reason cannot conflict with itself. Second, I examined Breitenbach's and Choi's account of unified pluralism. They argued that Kant's account of the regulative unity of science could offer support to contemporary pluralist methodologies. I argued that this would require a stronger commitment to Kant's transcendental idealism. Many disagreements between contemporary philosophers of science arise because of disputes that cannot be resolved in accordance with any possible experience. A communicative and collaborative science requires not merely that scientists agree on the issue their research is directed toward, moreover they must also agree on the boundaries of scientific knowledge to avoid falling into irresolvable disputes. Finally, I examined how contemporary appeals to consilience significantly differ from Whewell's original formulation. Wilson and Mackie appeal to consilience as a metaphysical principle in contemporary philosophy of science. Whewell argued that consilience was a methodological principle that demonstrated the correctness of a theory because it could be applied to other cases of facts. In contrast, contemporary philosophers of biology regarding consilience as a reductive universal demand for all

aspects of nature to be explained in terms of scientific principles. They argue that if any part of nature cannot be explained scientifically, then the entire project of consilience fails.

Chapter Four: Whewell's influence on Darwin and role of design in the organism

Introduction

This chapter examines the sources of influence on the development of Darwin's *Origin of the Species* to understand the relevant similarities and differences between the philosophies of Darwin and Kant. The two significant sources of influence on Darwin's theory are Herschel and Whewell. Their influences on Darwin relate to logically distinct arguments in Darwin's *Origin*. Darwin argues that the vestigial traits of organisms provides insight into their biological ancestry. This is closely aligned with Whewell's account of consilience discussed in the previous chapter because it draws on parsimony as evidence for the correctness of a theory, moreover the evidence in support of common ancestry draws from various biological disciplines. In contrast, Darwin's argument for natural selection is more closely related to Herschel's account which emphasises the importance of analogical reasoning.

Despite Kant's lack of direct influence on Darwin, Ruse has argued that Darwin would have agreed with Kant's account of the organism, or at least the features of the organism that can only be understood in accordance with design, as the product of teleological judgment. This appeal to Kant's philosophy as offering support to Darwin significantly distorts Kant's account of teleology as indispensable for viewing organisms. *Pace* Ruse, I argue Kant's philosophy raises important criticisms against fundamental aspects of Darwin's theory such as the relationship between artificial and natural sources of design in nature. For Darwin, artificial selection served as an analogical basis for understanding natural selection. In contrast, Kant argued that external purposiveness—which is similar to artificial selection—is fundamentally different to the internal purposiveness that organisms display.

The relationship between organisms and design has been a significant issue for the philosophy of biology. The underlying problem is that it seems that the design of organisms cannot be sufficiently justified in accordance with biological naturalism. For instance, Ratcliffe argues that Dennett's account of adaptationism can be understood as requiring Kant's account of teleological judgment. It follows that Dennett's account requires a non-naturalistic standpoint. In contrast, some contemporary philosophers of

biology have argued that it is not necessary to understand organisms in accordance with design at all.

The first section examines the extent of Whewell's influence on Darwin. This begins with an examination of how Kant's account of the organism influenced Whewell. Whewell extended Kant's account of teleological judgment to offer justification for conceiving of both biological entities and the natural laws more generally in accordance with theological design. In contrast, Kant argues that the ability to conceive of nature as the source of purposiveness is much more restricted. Following this, the influences of Whewell and Herschel on Darwin is discussed. I outline two distinct arguments in the *Origin*: the argument from common ancestry and the argument for natural selection. Common ancestry focuses on traits of a species that do not have a current use and identifies other species which also possess these traits. It is more probable that other species possessing these traits are linked by a common ancestor. In contrast, natural selection suggests that the traits that offer a benefit in fecundity to trait-bearers will be more likely to reproduce and pass on that trait. Each argument can be understood as attempting to satisfy the differing accounts of *vera causa* (true cause) developed by Whewell and Herschel.

Section two considers the relation between natural and artificial selection. The received view is that Darwin argued the changes produced in organisms in the context of artificial selection were analogous to the changes that could be produced by natural selection. Richards argues against this on the basis that the differences between natural and artificial selection constitute a difference in kind, rather than degree. In contrast, Ruse's argument that artificial selection in combination with Malthus' influence on Darwin allowed him to regard natural selection as going beyond the limits of artificial selection is examined. Following this, I consider Paley's influence on Darwin through his theological argument for divine design based on the analogy between artifacts and organisms. This is contrasted with Kant's rejection of this analogy because organisms are judged to possess a formative force whereas artifacts possess only a motive force. This shows that Kant would have rejected the analogy that Darwin and Paley appealed to in relation to organisms and artefacts. This is indicative of an important difference between the accounts of Kant and Darwin that Ruse overlooks as he argues that Kant's account of teleological judgment—as a heuristic principle—is compatible with Darwin. The idea that design can be perceived in nature in a merely regulative sense which can be explained away once the appropriate mechanism has been discovered is highly problematic.

Section three examines the role of design in contemporary philosophy of biology. I outline Gould's and Lewontin's criticism of adaptationism in relation to Ratcliffe's argument that Dennett's conception of an intentional stance requires a non-naturalistic foundation to explain how it is possible to conceive of nature *as if* it were governed by intentions. Ratcliffe suggests that Kant's account of teleological judgment offers a suitable ground for Dennett. I also examine Nicholson's account which argues thermodynamics has revealed why organisms are not the product of design. For Nicholson, organisms should be understood in the context of dissipative structures rather than machines or artifacts. Like dissipative structures, every component of an organism must perpetually maintain itself. I argue that the problem of design is resolved at the cost of distinguishing between organic and in-organic dissipative structures.

The final section of this chapter examines how the problem of defining organisms has remained a source of dispute in contemporary philosophy of biology. Differing conditions of biological identity offer incompatible accounts of the boundaries and number of organic entities. Generally, conceptions of biological individuality identify entities that express some degree of genetic homogeneity and functional integration. I examine paradigm cases of biological individuals as: genetically homogeneous, symbiotic functional integrations, and extended physiologies.

1. Whewell's influence on Darwin's *Origin*.

This section considers how Whewell's work influenced the development of Darwin's *Origin*. Whewell's account of design is compared with Kant's distinction between relative (or external) and natural (or internal) purposes. For Whewell, the ability to conceive of nature in accordance with design is evidence for nature as intentionally created by God. In contrast, Kant argued that we are significantly more limited in the conclusions that can be drawn from the experience of the purposiveness of nature. Kant recognised the connection between the appearance of design in nature and divine design, yet he argued that we could not infer God's design from our ability to conceive of nature teleologically. This section also outlines two main arguments in Darwin's *Origin*; the argument from common ancestry and the argument for natural selection. Each of these arguments can be understood in the context of the differing prevalent methodologies of

science in Darwin's time. I argue Darwin was attempting to satisfy the accounts of *vera causa* proposed by Whewell and Herschel, this helps us to understand the extent of Whewell's influence on Darwin.

1. The role of design in Whewell's philosophy

Whewell's account of biology drew from Kant's discussion of teleological judgment; however, he argued this supported a theological conception of design in nature. In contrast Kant argued that purposiveness can only relate to our judgment, and judgments of purpose can take two forms; either internal or external. Exploring these aspects of Kant's philosophy allows us to identify some fundamental differences between Kant's and Whewell's accounts of the organism.

Whewell's conception of biology was indebted to Kant's account of the organism. He argued that the fundamental idea required for biology was the Kantian definition of organisation in accordance with final causes; 'an organised product of nature is that in which all the parts are mutually ends and means' (Kant, cited in Whewell, HSI p.197). Life could not be reduced to any single function, rather, it must be understood as a system of functions. Biological organisms must be considered as including the idea of final causes as they cannot be separated from the inherent notions of end, purpose, and design. Whewell argued that this cannot be deduced from the phenomena, 'but is *assumed* as the only condition under which we can reason on such subjects at all' (HSI p.240). In other words, our relation to final cause is not given externally as a fact, but it is something generated from within the subject as an idea. This is an inherently Kantian aspect of Whewell's account as Kant also rejected any possibility that we could derive our conception of final cause from nature. According to Kant, 'it is absolutely impossible for us to draw from nature itself any explanatory grounds for purposive connections' (CJ 5:410). For both Kant and Whewell, final causes are necessary for the possibility of comprehending biological phenomena.

An essential difference between their accounts relates to the broader conception of nature in accordance with final causes. For Kant, the two ways that it is possible for us to judge our experiences of nature is either in accordance with mechanical or teleological principles. Kant presents this as the antinomy of the power of judgment. According to Kant, the thesis of this antinomy is that '[a]ll generation of material things and their forms must be judged as possible in accordance with merely mechanical laws' (CJ 5:387). The

antithesis is that '[s]ome products of material nature cannot be judged as possible according to merely mechanical laws' (ibid). This antinomy orients our investigation of nature by prescribing us to first investigate nature from a mechanical perspective. When nature cannot be sufficiently understood in accordance with mechanical laws, then we are permitted to judge nature in accordance with teleological laws. The regulative—rather than constitutive—status of this antinomy allows us to regard these two ways of orienting ourselves toward nature as complimentary to one another, rather than contradictory. According to Huneman,

> mechanism and teleology can be conceived of as two complementary explanatory stances. The first one uncovers processes at work in all of nature, and therefore it is not proper to biology. However, when facing a particular process taking place in an organism, it does not answer questions such as: why is this process here? […] This second explanatory stance clearly does not concern *non organized* entities.
>
> (Huneman, 2014, p.192)

Huneman correctly identifies the importance of the complementarity between mechanical and teleological judgments as regulative principles. However, I disagree with Huneman's relegation of teleological judgments to a type of question, a 'why' rather than a 'how' question, that can be asked of nature. This does not consider how the possibility of the experience of organisms in general requires the appeal to teleological judgments. In other words, it is not merely that teleological judgment allows us to direct certain questions toward experience that we would otherwise remain unaware of; rather, the very conception of the organism requires that we view it *as if* it were directed toward final causes.

Whewell was influenced by Kant's account of final causes as necessary for the conception of organisms, but he was not satisfied with the argument that these features of organisms could be understood as relating merely to judgment. Instead of prioritising the mechanical explanation over the teleological explanation of nature, Whewell argued that the use of metaphorical language that was potentially problematic for teleological explanations is also presupposed for mechanical scientific explanations. He argues that terms often used in the mechanical sciences such as energy and effort likewise imply volition and animated action. According to Whewell,

> We endeavour in vain to conduct our mechanical reasonings without the aid of this idea, and must express it as we can. Just as little can we reason concerning organized beings without assuming that each part has its function, each function has its purpose (HSI p.251)

This focus on the use of metaphor within science shows a strong similarity with Lewontin's account of science discussed in the introduction to this thesis. Lewontin argued that '[i]t is not possible to do the work of science without using language that is filled with metaphors' (Lewontin, 2000, p.3). Lewontin warned that the price of using such metaphors was eternal vigilance against mistaking these metaphors for the real objects of interest. For Whewell, vigilance against metaphor is replaced with an appeal to theology; our ability to perceive design in nature is evidence for the divine design of nature. According to Whewell, '[i]f men really can discern, and cannot help but discerning, a design in certain portions of the works of creation, this perception is the soundest and most satisfactory ground for the conviction to which it leads' (HSI p.252). Moreover, this design is not limited to biological organised beings; he argues that even mechanistic scientific laws can be understood in teleological terms. Whewell explains that the Copernican revolution did not cast doubt on the idea that the sun is intended to offer warmth and vitality to plants and animals because of the discovery that the Earth revolves around the sun. According to Whewell,

> Final causes, if they appear driven further from us by such an extension of our views, embrace us only with a vaster and more majestic circuit: instead of a few threads connecting some detached objects, they become a stupendous net-work, which is wound round and round the universal frame of things. (HSI p.254)

This raises an important question regarding our warrant for comprehending design in nature. Whewell's argument that design in nature is evidence for divine creation reveals the potentially expansive way that nature can be understood in accordance with design. Whewell acknowledged that the way design is comprehended in the case of the solar system is different from the way design is comprehended for organic entities; in the former it is comprehended at the level of laws rather than at the level of individual entities. According to Whewell, '[t]he principle of design changes its mode of application indeed, but it loses none of its force' (HSI p.253).

Kant's account of teleological judgment is more critical than Whewell regarding our justification to perceive nature as the source of design. Kant recognised that many aspects of our experience of nature seem to exemplify design, but our warrant to claim that this design is produced by nature is highly problematic. He distinguishes between relative (or external) purposes and natural (or internal) purposes. The former relate to aspects of nature where design is expressed in terms of its usefulness or advantageousness

for humans or other creatures. Kant explains that nature seems to exemplify purpose and design for other creatures in a merely relative sense. According to Kant, 'if cattle, sheep, horses, etc. were even to exist in the world, then there had to be grass on the earth' (CJ 5:368). External purposiveness is also exemplified by the way that humans use nature for their own ends. For Kant, Humans use nature for 'foolish ends' such as decorating and dying their clothing with feathers, soils and juices. Humans also use nature for rational ends such as riding horses and using swine and ox to plough fields. In these cases, the purpose in question is always external and directed toward another aspect of nature. Kant argues that this cannot justify the idea that any entity itself possesses such a purpose unless we presuppose that the entity which it is a purpose for is assumed to necessarily exist. According to Kant,

> Only **if** one assumes that human beings have to live on the earth would there also have to be at least no lack of the means without which they could not subsist […] those things in nature which are indispensable for this purpose would also have to be regarded as natural ends (ibid)

Kant concludes that relative purposes merely hypothetically indicate the existence of natural purposes but cannot amount to absolute justification for them. Relative purpose cannot offer any justification for why the entity must exist, which is required for our warrant to conclude that such purposes are essentially natural. It doesn't reveal that purposiveness is necessarily an internal trait of the entity for it is possible that such purpose is a product of the judgment applied to that entity.

Pace Kant, Whewell aimed to show that man was predestined to exist in nature, and the ability for man to spy design in nature was evidence of this divine designer. According to Yeo, Whewell 'believed that man's ability to understand the laws (and thoughts) of God implied a threefold harmony between the mind of God, the mind of man and the laws of nature' (Yeo, 1979, p.498).[55] In this context, Whewell's theological commitment results in an unwarranted extension of design and purpose as part of nature. From the perspective of transcendental idealism, the underlying concern is that we mistake those features of nature that exemplify design and purpose which can be justified only as external purposes, for manifestations of design and purpose in nature independent of our judgments.

[55] For Whewell, the mind of humans can only comprehend the mind of God in a limited sense. Whewell compares the former to the shores of the sea and the latter to the ocean. See Chapter Three (1.3).

The difference between the accounts of biology developed by Whewell and Kant is important for understanding their significance for Darwin. Darwin's account of natural selection developed an alternative explanation for biological development that was not significantly influenced by either Kant or Whewell. Whewell's conception of consilience discussed in the previous chapter was a much greater influence on Darwin's theory. In this sense, Kant's indirect influence on Darwin was his influence on the development of Whewell's philosophy of science, specifically his conception of consilience. It is indirect because Whewell attempted to offer a naturalistic account of the demand for scientific unity by showing historically that examples of consilience have never been proven false, rather than offering a transcendental justification for unity as a regulative demand of reason. Whilst Kant influenced the development of Whewell's philosophy, Whewell transformed aspects of Kant's account so that he could establish a philosophy of science that related to things in themselves.[56]

This short outline of Whewell's account of biology has considered Whewell's appeal to theology to account for the apparent design and purpose of nature as evidence for man's purposiveness in accordance with a divine creator. Kant influenced Whewell's conception of biology, but Whewell's account of external purposiveness as justification for divine creation is not compatible with Kant. Kant denied that external purposiveness could support claims that these purposes are in nature or that they are evidence of the intentions of God's design. The conceptions of biology developed by both Kant and Whewell were not significantly influential on the development of Darwin. This does not mean that there are not important comparisons that can be drawn between the accounts of biology developed by Kant and Darwin in relation to the application of design to nature.

2. The influence of Whewell and Herschel on the arguments of Darwin's *Origin*

Darwin famously concluded the *Origin* with the claim that it contained 'one long argument' (Darwin, 2003, p.379).[57] The idea that the *Origin* contained one argument has been questioned by various philosophers of biology. For instance, Mayr argues that

[56] This relates to the conception of influence developed in the first chapter which argues that influence should not be limited to the condition of similitude but should also allow for the possibility that influence can be based on misunderstanding or misprision. See Chapter One (4).

[57] All references to Darwin's *Origin* correspond to the first edition (1859). The reason for selecting this edition is because the later editions contain less adequate expositions of Darwin's theory of natural selection. See editorial discussion on the text by Carroll (Darwin, 2003, p,76)

Darwin's theory contained five sub-theories (Mayr, 1991, pp.36-37), and possibly more depending on divisions that individuals may prefer to impose. In contrast, Sober has argued that the *Origin* contains two logically distinct arguments: the argument for natural selection and the argument from common ancestry. By outlining Sober's account it is possible to identify the underlying tension between these arguments and the differing methods of evidential support for each.

Darwin begins with the argument for natural selection based on illustration by, or analogy to, artificial selection. According to Sober, the argument from analogy is evidentially weaker than the subsequent argument from common ancestry. According to the argument from common ancestry, certain traits do not increase the overall fitness of an organism and therefore cannot be regarded as a direct consequence of natural selection. These vestigial traits, which often have no current use, can be used as evidence for common ancestors because there is a greater probability that species possessing this trait are linked with other species which also possess the trait. Sober considers the evidence for a common ancestor between humans and monkeys on the basis that both have tail bones:

> It is false that human beings and monkeys must both have tailbones if they have a common ancestor. It is also false that they cannot both have tail bones if they lack a common ancestor. What is true is that the probability of this similarity is greater under the common ancestry hypothesis. (Sober, 2009, p.28)

Evidence for common ancestry does not amount to certainty for each case. Rather, it is merely the most probable explanation for this similarity. The hypothesis is most probable in virtue that tailbones do not have a current use in human beings. In contrast, it is possible that this trait does not reveal a common ancestor in cases where a trait is present in two species which increases the fitness for both trait-bearers. It is more probable that such traits emerged because of selective forces in which biological entities have 'become adapted to similar conditions, and thus assume a close external resemblance; but such resemblances will not reveal—will rather tend to conceal their blood-relationship to their proper lines of descent' (Darwin, 2003, p.360).

Darwin appeals to many different areas of biology to show examples of common ancestors. For instance, Darwin considers cases where there are similarities between different biological groups during embryological development which disappear once

members of the groups reach maturation. Darwin argues that such similarities are evidence for common ancestry,

> In two groups of animals, however much they may at present differ from each other in structure and habits, if they pass through the same or similar embryonic stages, we may feel assured that they have both descended from the same or nearly similar parents […]. Thus, community in embryonic structure reveals community of descent.
>
> (Darwin, 2003, p.373)

In virtue of the greater evidential support for common ancestry over natural selection, Sober questions whether Darwin's *Origin* was written backwards. He concludes that 'the book is in the right causal order, but evidentially, the book is backwards' (Sober, 2009, p.44). One reason that the argument for natural selection is evidentially weaker than the argument for common ancestry is because support for the theory is established by analogy with artificial selection.[58] This difference between the kinds of support offered for each argument should be understood in the context of the prevalent accounts of the methodological practices of his time.

The two prevalent methodologies of science during the development of Darwin's *Origin* were developed by Herschel and Whewell. The predominant interpretation is that Darwin's use of the principle of consilience is evidence of Whewell's influence. Ruse has strongly advocated this interpretation which has informed contemporary Whewell scholarship.[59] Darwin's appeal to many different disciplines in biology as supporting common ancestry demonstrates the importance of consilience within Darwin's account. However, the relationship between Whewell, Herschel, and Darwin has been the source of much dispute.

Ruse's account of Hershel's and Whewell's influence on Darwin has changed over time. Examining how his account has changed reveals some important differences between the methodologies of Herschel and Whewell. In an early essay on the subject, Ruse argued that both Whewell and Herschel could be considered under the more general 'Herschel–Whewell philosophy of science' (Ruse, 1975, p.166). In response, Thagard explained how the procedures of establishing *vera causa* principles (or true causes) were significantly different for Herschel and Whewell. For Herschel, a v*era causa* principle is derived by identifying analogies that reveal an underlying natural cause, whereas

[58] This is discussed in more detail in the next section. See Chapter Four (2.1)
[59] (cf. Snyder, 2006, p.185)

Whewell argued that true causes were revealed when a theory achieved a consilience of inductions.

Each account of *vera causa* was influential on different aspects of Darwin's theory. Darwin's discussion of the analogy between artificial and natural selection can be understood as appealing to Herschel's methodology. According to Herschel, '[i]f the analogy of two phenomena be very close and striking, while, at the same time, the cause of one is very obvious, it becomes scarcely possible to refuse to admit an action of an analogous cause in the other' (Herschel, 1996, p.149). For example, Herschel suggests that a stone which is swung in a sling in a circular motion is analogous to the moon orbiting the Earth. According to Thagard, overall Darwin was adopting a Whewellian account of *vera causa* as consilience; 'all that mattered is that it explained several classes of facts and thus achieved a consilience of inductions. Hence Darwin did not need the analogy between natural and artificial selection to show that natural selection is a true cause' (Thagard, 1977, p.356). Ruse responded to Thagard by conceding the difference between *vera causa* for Whewell and Herschel. He explains this difference as follows:

> Herschel, whilst recognizing the importance of a consilience, did not in itself elevate it to the status of something showing a *vera causa;* rather, he kept always with his analogies for the defining mark of a *vera causa.* Whewell on the other hand argued that a Herschellian *vera causa* is no *vera causa,* and that the only real *vera causa* is a cause at the centre of a consilience. (Ruse, 1978, p.328)

Pace Thagard, Ruse argues it is misleading to simply argue that Darwin was influenced by either Whewell or Herschel because they offer incompatible accounts of establishing *vera causa* principles. It is not necessary to set the influences of Herschel and Whewell against one another as Darwin's appeal to consilience is compatible with both. This potentially underplays the difference between Herschel and Whewell. For instance, Whewell's and Herschel's accounts of *vera causa* are, at times, contradictory. Whewell denies that analogy could serve as the basis for *vera causa* principles because it would allow for entities such as eddying streams to be evidence for the Cartesian hypothesis of vortices as a *vera causa* (PIS II p.283).

It has also been argued that Whewell could not have been significantly influential on the development of the structure of Darwin's argument as it didn't alter from 1838 which was prior to the publication of Whewell's account of consilience (Pence, 2018, pp.122-3). Yet, there are several passages of Darwin that are only compatible with the

Whewellian account of *vera causa* as requiring a consilience of inductions. For instance, Darwin concludes that if several classes of facts can be explained in accordance with common ancestry and transmutation, then he 'should without hesitation adopt this view, even if it were unsupported by other facts or arguments' (Darwin, 2003, p.378). This does not support the Herschelian conception of *vera causa* because consilience could not demonstrate correctness if it were unsupported by other forms of argument. Therefore, even if Whewell's account was not significant to the development of Darwin's account, it offered subsequent justification that supported Darwin's account of common ancestry.

The reception of Darwin's theory also supported a Whewellian interpretation. The arguments for the transmutation of the species and common ancestry were received with a greater level of positivity and acceptance than the argument for natural selection.[60] Waters argues that this would be inconsistent if those sympathetic to Darwin's theory approached Darwin from a Herschelian methodology. According to Waters, '[i]f natural selection is removed, the alleged *vera causa* vanishes, the Herschelian argument collapses, and there is no reason for accepting transmutation or common descent' (Waters, 2003, p.123). Hence, regardless of Darwin's own intentions for the methodology of the *Origin*, its reception favoured a Whewellian, rather than a Herschelian, interpretation.

The prevalence of a Whewellian conception of consilience as supporting Darwin's argument is inherently problematic when considered in the context of the previous chapter. Whewell's conception of consilience had been influenced by Kant. For Kant, the unity of nature was a regulative demand of reason that was necessary for the possibility of scientific enquiry. Whewell deviated from Kant's philosophy because he rejected both Kant's restriction of knowledge to the fixed forms of the categories and the rejection of knowledge of things in themselves. In contrast, Whewell argued that knowledge was a fundamental antithesis between thoughts and things. This was the foundation of the further antithesis between facts and theories. Theories must adequately colligate facts under a single rule. When theories can be applied to a set of facts belonging to a different class this demonstrates consilience and reveals beyond doubt that the theory is true. Whewell's account depended on a theological ground for the resolution of the fundamental antithesis and his conception of consilience.

[60] This is discussed in more detail in the next section.

Regardless of whether Darwin derived his account of consilience directly from Whewell, Darwin must explain why consilience should be regarded as an explanatory virtue for a theory. Darwin provides no justification as to why a theory that can be applied to a greater variety of facts should be preferable to a theory that has a smaller application. For Kant, this is justified in accordance with the regulative demand of reason (CPR A653/B681), whereas for Whewell justification is conceived in accordance 'with God's grand design'. Darwin's use of consilience is declaration rather than justification; he merely asserts that he would not hesitate to adopt the argument from common ancestry because it is parsimonious. He does not provide broader justification for why consilience would require us to accept a theory without hesitation (cf. Darwin, 2003, p.378).

This section has outlined the fundamental structure of two main arguments in Darwin's *Origin.* It has also considered how each of these arguments is supported by different conceptions of the methodologies of science that were contemporary to Darwin. I have suggested that the reception of Darwin amongst sympathisers seems to indicate that they understood Darwin in accordance with Whewell's conception of *vera causa*. It is also conceivable that whilst Whewell's influence might not have contributed to the original conception of the *Origin*, the subsequent support offered by Whewell nevertheless provided Darwin with a greater degree of certainty based on the *vera causa* principle of consilience.

2. Darwin and design: The relation between artificial and natural selection in Darwin's *Origin*

This section examines the relation between artificial and natural selection in Darwin's *Origin*. Richards has argued that Darwin could not have intended this relation to be analogical because of the insurmountable differences between artificial and natural selection. In contrast, Ruse has argued that Darwin's account of artificial selection, taken in combination with the influence of Malthus, reveals how natural selection should be understood as analogous to the former, despite the various ways that natural selection extends beyond artificial selection. Following this, I consider Paley's influence on Darwin through his account of biological design as supporting divine design. Paley's thought experiment of finding a watch on a heath as evidence for divine design is

compared to Kant's distinction in kind between artefacts and organisms. Kant would have denied the analogy between organisms and artefacts that is central to both Paley's and Darwin's accounts. This has significant implications for Ruse's interpretation of Darwin which appeals to Kant's conception of teleological judgment as offering support to Darwin's account of design.

1. The relation between artificial and natural selection

Darwin's discussion of artificial selection focuses on our power to identify traits and characteristics of animals and plants and breed only from those which best display these traits and characteristics to increase their frequency in future generations. According to Darwin, 'man can act only on external and visible characters: nature cares nothing for the appearance, except in so far as they may be useful to any being. […] Man selects only for his own good; nature only for that of the being which she tends' (Darwin, 2003, p.146). The analogy between artificial and natural selection has been a topic of dispute within scholarship.

For instance, many of Darwin's contemporaries regarded artificial selection as evidence against the causal efficacy of natural selection because it could not produce new species (Richards, 1997, p.77). Natural selection entails an increase in fitness for organisms possessing traits that are selected, whereas artificial selection has no relation to increasing fitness. In regard to artificial selection, traits are selected in accordance with the intentions of breeders. According to Richards, 'in terms of fitness, the difference is one of kind. Natural selection favours fitness, while artificial selection opposes it' (Richards, 1997, p.84). For this reason, Richards argues that Darwin's appeal to artificial selection is merely a psychological heuristic for illustrating some similarities with natural selection. There are too many incompatibilities between artificial and natural selection for it to be considered an argument from analogy; '[i]f we deny this, then it is unclear what would ever count against an analogical argument' (Richards, 1997, p.95)

In contrast, Ruse has argued that there is an analogical argument between artificial and natural selection, but that this must be understood in the context of Malthus' influence on Darwin. According to Ruse, '[b]efore reading Malthus, Darwin, if anything, stressed reasons why one who believed in evolution should not draw an analogy with domestic organisms' (Ruse, 1975, p.343). The pre-Malthusian Darwin accepted that the incompatibilities between the two forms of selection were so great that no analogy could

be drawn between them. Ruse denies that this meant that Darwin's theory developed independently of his awareness of artificial selection; rather he had not yet found the principle which accounted for the differences between them. This principle was the struggle for existence that Darwin attributed to Malthus' doctrine when applied to the whole animal and vegetable kingdoms. Malthus revealed to Darwin that since more organisms are 'produced than can possibly survive, there must in every case be a struggle for existence' (Darwin, 2003, p.134). Reproduction increases as a geometrical ratio, but organisms can only be sustained at an arithmetical ratio which is inevitably exceeded. On this principle, individuals that manifest variations that increase fitness are naturally selected. According to Darwin,

> as all organic beings are striving, it may be said, to seize on each place in the economy of nature, if any one species does not become modified and improved in a corresponding degree with its competitors; it will soon be exterminated. (Darwin, 2003, p.157)

Only by considering artificial selection in combination with Malthus could Darwin account for both the similarities and the differences between artificial and natural selection. For artificial selection, traits are selected—either consciously or unconsciously—based on the use or value that they have for breeders. For natural selection, traits are selected that increase the fitness of individuals over their competitors. For the former, speciation cannot be explained as any changes are limited, whereas changes produced by the latter are unlimited and therefore speciation can be explained (cf. Darwin, 2003, p.162). Natural selection exceeds the boundaries of artificial selection when it is considered from a Malthusian perspective. According to Ruse, natural selection 'had not been thought to be so useful because it was, as it were, "dragged down" by the analogy from domestic organisms […]; after Malthus, it was seen that natural selection can far outstrip its analogical relative' (Ruse, 1975, p.350).

By focusing on the relationship between artificial and natural selection, Darwin avoids explaining what constitutes an organism.[61] Knowledge of organisms is inherently unproblematic, possibly because they were already utilised with great success in cases of artificial selection. The similarity between artificial and natural selection also allowed Darwin to avoid providing a specific definition of species; he merely asserts that 'every naturalist knows vaguely what he means when he speaks of a species. Generally the term

[61] The problem pertaining to the definition of the organism is still an issue in contemporary philosophy of biology. This is discussed in the final section of this chapter (4).

includes the unknown element of a distinct act of creation' (Darwin, 2003, p.122). This marks a significant difference between the accounts of Kant and Darwin. Kant's treatment of teleology in its external and internal forms differs from Darwin's account of artificial and natural selection as Kant was not concerned with our ability to select traits that induce physiological changes in progeny. He was not concerned with the changes that can be produced by artificial or natural selection, only with our warrant to judge nature as the source of purposiveness. As discussed in the first section of this chapter, Kant was also aware that humans often use organisms for their own ends, yet none of these uses justify the idea of natural purpose. The ability to use nature for our own ends does not establish our warrant for conceiving of nature as the source of its own teleological ends.

Darwin's analogy between artificial and natural selection does not consider the philosophical problem raised by Kant, specifically that if the source of the intended use is external to the entity that is changed then this cannot be regarded as an internal purpose. It could be argued that Darwin avoids this problem because he appeals to the phylogenetic changes that can be produced by both artificial and natural selection as evidence for their belonging to the same power. According to Darwin, 'if a feeble man can do much by his powers of artificial selection, I can see no limit to the amount of change […] which may be effected in the long course of time by nature's power of selection' (Darwin, 2003, p.162). Thus, for Darwin the semblance between artificial and natural selection is not the source of design, but the capacity for phylogenetic change based on selective forces more generally. In this sense, Darwin does not regard the selective forces of artificial and natural selection as different in kind.

2. The distinction between organisms and artefacts for Darwin, Paley and Kant.

Darwin is known to have read Paley as a student at Cambridge. Like Kant, Paley recognised that the apparent design of organisms could not be the product of chance. According to Kant, 'nature, considered as a mere mechanism, could have formed itself in a thousand different ways without hitting precisely upon the unity in accordance with such a rule' (CJ 5:360). Unlike Kant, Paley proposed that the only possible explanation for design in nature was theological. Paley's *Natural Theology* commences with the following thought experiment. Suppose we find a watch on a heath. We would immediately regard the watch as the product of design as its parts are put together to serve

a purpose. This would not be the case if we found a stone rather than a watch. Even if we have never seen a watch before, or the watch is in some way defective, we would still regard it as the product of a designer (Paley, 2009, p.2). Paley asks us to imagine that this watch has the unexpected property of producing another watch, like itself. According to Paley,

> Though it be now no longer probable, that the individual watch which our observer had found, was made immediately by the hand of an artificer, yet doth not this alteration in anywise affect the inference, that an artificer had been originally employed and concerned in the production. (Paley, 2009, p.11)

This thought experiment served as the basis for Paley's argument that '[t]here cannot be design without a designer' (Paley, 2009, p.12) which allowed him to consider the design behind biological mechanisms exhibited in nature as the product of intelligent design.[62] This watch possessing the capacity to produce other watches is analogous to the properties possessed by organisms. Darwin's deviation from Paley was not the rejection of design in nature, but rather his rejection of the claim that such design required a designer. According to Ayala, 'Darwin's argument addresses the same issues as Paley's: how to account for the adaptive configuration of organisms, the obvious "design" of the parts to fulfil their particular functions' (Ayala, 2008, p.70). Hence, Darwin did not deny that nature is designed.

There is a strong similarity between Darwin's account of artificial selection and Paley's self-replicating watch. The watch, much like the traits that are artificially selected by breeders, could never arise by means of natural selection. For both, their functions are not selected based on adaptive success; rather the selecting force is located outside of the entity.

In addition to Kant's criticism against the analogy between artificial and natural selection, Kant would have also been critical toward Paley's thought experiment. Kant denied that finding a shape drawn in the sand on a deserted beach is analogous to our comprehension of organisms. Much like the watch, the shape drawn in the sand can only be understood as a product of reason rather than nature (CJ 5:370). The possibility that nature unguided by intentions could have produced such a shape is infinitely small, so this serves as justification for

[62] For examples of Paley's discussion, see Ayala (2002, pp.15-6).

conceiving of the shape in the sand as the product of an end, but not a natural end. A natural end requires us to regard the entity itself as both the source and referent of its own organisation. This is the fundamental distinction between artefacts and organisms as the former is dependent on the plan of another, whereas the purposiveness of organisms is judged as emerging from nature. Artefacts can only produce motion in accordance with an idea of the whole which is the cause of the production of the artefact, but it does not contain the ability to generate itself in accordance with this idea. Hence, he denies the possibility that a watch could possess the powers that are specific to organised beings. According to Kant,

> one wheel in the watch does not produce the other, and even less does one watch produce another, using for that purpose other matter (organizing it); hence it also cannot by itself replace parts that have been taken from it, or make good defects in its original construction by the addition of other parts, or somehow repair itself when it has fallen into disorder: all of which, by contrast, we can expect from organized nature. ‑ An organized being is thus not a mere machine, for that has only a **motive** power, while the organized being possesses in itself a **formative** power. (CJ 5:374)

Kant is in agreement with Paley and Darwin insofar as the appearance of organic entities exhibits design. However, he denies that any knowledge of the natural purposiveness of nature can be derived from our knowledge of external purposiveness or purposes exhibited by artefacts. Both Darwin and Paley sought to establish a common ground between artificial and natural purposes, albeit in different ways. Paley appealed to divine design in combination with the similarity between our own organisation and the organisation of machines, whereas Darwin argued that the idea of an unlimited naturally selecting force can be understood if artificial selection is considered in combination with Malthus. In contrast, Kant sought to isolate these forms of purposiveness from one another. Kant differentiated our awareness of organisms from our awareness of other kinds of objects. He denies the coherence of Paley's example of the self-replicating watch because machines cannot reproduce their whole or their parts. Hence, he proposed a threefold division of types of objects into 'man-made artefacts, inorganic objects, and living organisms' (Zumbach, 1984, p.4). Inorganic objects are differentiated on the basis that the experience does not require us to view their organisation in relation to a function they ought to achieve. According to Ginsborg, 'there is nothing which a stone ought to be. We may judge a stone to be sound or defective with respect to some particular human purpose […] [b]ut we cannot describe it […] as sound or defective *tout court*' (Ginsborg,

2015, p.239). In contrast, the functions of both organisms and man-made artefacts can be understood in terms of how they ought to be, and thus they can be considered as defective if they are malfunctioning.

There has been a tendency to overlook the essential dissimilarity between organisms and machines within Kant scholarship. For instance, Ginsborg has noted that McLaughlin correctly identifies the difference in kind between these entities, but then seems to underplay this difference in his further treatment of the antinomy between teleology and mechanism. According to McLaughlin, teleological explanations are appealed to when mechanistic explanations are currently insufficient. However, this does not entail that it will not be possible to provide a mechanistic explanation at some point in the future. Teleological judgment

> never impedes the possibility of a later mechanistic explanation […]. Whether or not, in a thing that we have to conceive as a natural purpose, an unimaginable, non-mechanical, real causality is active, we can never know with certainty. (McLaughlin, 1990, p.178)

In this case, teleological judgments are required for judging aspects of nature that are currently inconceivable in accordance with mechanical judgment. It is important to distinguish two possible ways to understand mechanism in this context. Mechanism could be understood as either relating to a machine or relating to a law. This difference is significant because the former does not exclude the need to appeal to teleology. According to Ginsborg, 'for Kant there is no less of a need for teleology in understanding a machine such as a watch, than there is in understanding an organism' (Ginsborg, 2015, p.285). A machine is teleological in the sense that it requires a motive power or purpose that is external to the machine, whereas organisms possess a formative power that is internal and responsible for self-organisation, repair and reproduction. In this context, McLaughlin's account of mechanism is not related to machines but to laws.

The requirement that teleology should explain organisms in accordance with ends signifies a similarity between organisms and artefacts. However, it is possible that future developments of our knowledge will offer a mechanical explanation of what was previously conceived teleologically. The discovery of this mechanism would entail that there is no longer any need to appeal to a partial similarity between organisms and machines as there would no longer be the need to appeal to teleology to explain organic entities. According to McLaughlin,

> Should it turn out that a phenomenon judged teleologically can be explained mechanistically, e.g. on the basis of newly discovered empirical laws, no contradiction can arise between the new mechanistic explanation and the superseded teleological explanation; what was teleological in the old explanation becomes superfluous and what was mechanistic in the old explanation remains valid. (ibid)

The problem with McLaughlin's account is that if the possibility of judging organic entities requires that they are viewed as possessing a formative drive, then in principle there could not be the discovery of any new mechanistic law that could be suitable to supersede the teleological explanation. McLaughlin concedes the possibility 'that a purely mechanical explanation of the organism may perhaps never be successful without abandoning mechanism as the ideal of explanation' (McLaughlin, 1990, p.179). This inability to explain organisms in terms of mechanical explanations should not be regarded as a shortcoming of Kant's philosophy. According to Lovejoy, Kant would have opposed Darwin's purely mechanistic explanation as he 'was most of all hostile to the supposition that any of the phenomena of organic life can be completely explained mechanistically' (Lovejoy, 1968, p.175).

The idea that Kant would have opposed Darwin's mechanistic explanation of life is further complicated by interpretations that suggest Darwin was not offering a mechanistic account. This has been central to the ongoing dispute between the interpretations of Darwin proposed by Ruse and Richards (cf. Ruse, 2003; Richards, 2004; Richards & Ruse, 2016). For Ruse, Darwin was a mechanist. The influence of the industrial revolution on Darwin's thought led Darwin to consider natural selection through an industrial lens. According to Ruse, '[t]his means competition, it means Progress, and above all it means machines' (Ruse, 2016b, p.177). Darwin regarded God as the 'Supreme Industrialist' who created the machine of natural selection. Once the machine has been created, God becomes a 'retired engineer'. Thus, Ruse argues that Darwin did not regard God as necessary for natural selection at every moment; 'God is not needed. At most we have metaphors' (Ruse, 2016b, p.199).

Ruse acknowledges that Darwin never refers to Kant on the apparent or metaphorical design of nature, but he asserts that Darwin would have agreed with Kant insofar as 'you cannot do biology without the metaphor. The point is that there is no implication of an Aristotelian vital force objectively out there in nature making for final causes. Final causes are our way of thinking about a mechanistic system' (Ruse, 2016a, p.47). The metaphor of design is applied to the organism to stimulate new avenues of

scientific enquiry by considering the possible adaptive functions of traits. Elsewhere, Ruse has suggested that biology could continue without the metaphor of design only in a limited sense in fields such as embryology, physiology, and classification:

> If we want a biology that is not interested in the reason why the stegosaurus has such a funny display on its back, is not intrigued by the peculiar shape of the trilobite lens, does not care why some butterflies mimic other butterflies, is unconcerned about the spirals of the sunflower, then presumably something can be done.
>
> (Ruse, 2003, p.284)

For Ruse, metaphorical thinking allows us to consider biological organisms *as if* they are the product of design. This allows him to preserve teleology as it figures in Darwin's account as a merely heuristic principle. Final causes are not a necessary condition for the comprehension of organisms, rather they only make it possible to ask why biological entities seem to have certain functions. Once these final causes can be explained in terms of their underlying mechanisms, then these final causes can be eliminated from biology.

Ruse's appeal to Kant is inconsistent with Kant's own explanation of the organism. According to Richards, 'Ruse fails to take the role of metaphor […] in science seriously. He assumes that they can be eliminated while leaving theory intact' (Richards, 2004, p.37). For Kant, final causes are not merely heuristic in the sense that we can choose to apply them to our experiences of organisms to allow us to enquire into why certain biological entities have developed particular functions.[63] Final causes are a precondition of experiencing an entity as organic rather than non-organic. According to Kant, the 'maxim of the reflecting power of judgment is essential for those products of nature which must be judged only as intentionally formed and thus not otherwise, in order to obtain even an experiential cognition of their internal constitution' (CJ 5:398). In this sense, Ruse's appeal to Kant is misleading insofar as Kant's account of teleological judgment requires that final causes are necessary for the 'experiential cognition of the internal constitution' of biological entities.

Moreover, Kant's account of teleological judgment cannot be separated from the broader context of his critical philosophy. Kant's account of teleological judgment must be understood in the broader context of his account of theoretical and practical philosophy. According to Guyer, 'it is only our awareness of the freedom of our own

[63] This was also the basis for Huneman's claim that mechanical and teleological ways of conceiving nature were complimentary to one another. See Chapter Four (1.1).

purposiveness that leads us to conceive of the purposiveness of organisms as necessitating a fundamental split between the teleological and mechanical views of nature' (Guyer, 2001, p.264). In this sense, Kant's account of teleological judgment was not influential on the development of Darwin's conception of biology and emerged from a significantly different context to Darwin. For these reasons, it is problematic for Ruse to appeal to Kant's conception of teleology as offering support to Darwin. Ruse appeals to Kant to show how Darwin could preserve the role of teleology as a merely heuristic principle that could guide scientific enquiry. Yet, this is inconsistent with the original formulation of Kant's discussion of teleological judgment because his conception of organisms is essentially non-mechanical. Whilst Kant argues that we must approach nature mechanically as far as is possible, this does not entail that it will be possible to explain even a mere blade of grass without viewing it as the product of intentions. In this sense, Kant's account of teleological judgment is not helpful for understanding Darwin unless we are willing to concede that natural selection requires a transcendental method to account for the conception of organisms.[64]

In contrast, Richards argues that Darwin was greatly influenced by German Romanticism which revealed to Darwin that natural selection was essentially a creative process, rather than mechanistic. According to Richards, '[n]ature hardly operates like a clattering and wheezing Manchester mechanical loom, rather like a subtle and refined mind that can direct development in an altruistic and progressive way' (Richards, 2004, p.33). The ultimate goal of natural selection is human beings. Richards argues that the inherent design and purposiveness of natural selection demonstrated to Darwin that the biological laws are 'produced by an intelligent mind governing the universe' (Richards, 2016b, p.161).

For Richards, Kant and Whewell are not significant sources of influence on Darwin's theory. He argues that Kant's influence on Whewell 'forbade a philosophical leap into the transcendent sphere to explain the designed structure of organisms' (Richards, 2016a, p.110). In this sense, he argues that Whewell's position is similar to contemporary accounts of scientific creationism and intelligent design. Darwin revealed how this division between theology and nature could be overcome by understanding nature as containing an intelligent selecting force. According to Richards, natural

[64] This is discussed in the next section in relation to Dennett's account of natural selection.

selection is an intelligent and altruistic selecting force located within nature: 'the process works for the good of the organism, unlike actions of the human breeder; that is, natural selection is an altruistic process, while human selection is selfish' (Richards, 2016a, p.127). Artificial selection does not select on the basis of environments that are good for animals. Darwin explains that humans keep animals which are native to many different climates in the same conditions; providing them with the same exercise and feed, and often selecting half-monstrous forms to breed from. Artificial selection impedes natural selection which only selects traits that make them better suited to their environments: 'natural selection can act only through and for the good of each being, yet characteristics and structures, which we are apt to consider as of very trifling importance, may thus be acted on' (Darwin, 2003, p.146). That natural selection is directed toward the good of each being suggests that Darwin regarded natural selection as an intentional progressive selecting force. Natural selection is a progressive force that selects traits that will develop improvements for each being by making them better suited to their environment. According to Richards, '[n]o machine could see into the very fabric of creatures, could detect very small, virtually imperceptible, variations for selection' (Richards, 2016a, p.125).

This section has examined the relationship between artificial and natural selection in Darwin's *Origin.* I examined the difference between Kant's denial of appeals to the beneficial ends that humans and other animals achieve in nature as a basis for conceiving of the organisms as possessing natural purposes or a formative drive. This was compared to the differing accounts of the relation between machines and organisms proposed by Paley and Kant. Kant would have denied Paley's thought experiment of the self-replicating watch as evidence of divine creation because of fundamental differences between organisms and machines. For machines, the source of design is located outside of the entity as a motive force, whereas organisms contain an internal formative force. I explained two possible ways that mechanism could be understood within Kant's philosophy as either relating to machines or laws. Finally, I considered the extent to which Darwin's account of natural selection should be understood as a mechanistic philosophy. For Ruse, natural selection requires the need for design as a heuristic principle that was supposedly compatible with Kant's account of teleological judgment. Kant's account of the organism would not be compatible with Ruse's interpretation of Darwin because Ruse restricts teleology merely to enquiry into why organisms have certain traits. This does not

relate to the possibility of the empirical conception of organisms as Kant had argued. In contrast, Richards argues that natural selection should not be understood as a mechanical industrial force, but rather as an intentional selecting force that had been inspired by Darwin's exposure to the ideas of German Romanticism.

3. Organisms and design in contemporary biology

This section examines the relation between teleology and design in contemporary philosophy of biology. It begins by briefly explaining Kant's account of organisms in the Third *Critique* and then considering the criticism against adaptationist thinking raised by Gould and Lewontin. Following this, I discuss Ratcliffe's argument that Dennett's account of adaptationism requires a non-naturalistic Kantian ground to explain how it is possible to view nature in accordance with intentions. Finally, I examine how some contemporary philosophers of biology have opposed the idea that the conception of organisms requires design. Developments in our understanding of thermodynamics suggest that organisms are not analogous to machines, but rather should be understood as more complicated manifestations of non-organic dissipative structures such as eddies or storm systems.

1. Kant's account of design and its relation to contemporary philosophy of biology

For Kant, the possibility of conceiving of organisms as a 'cause and effect of itself' (CJ 5:371) requires that the following three conditions are met: first, it reproduces; second, it repairs and generates itself as an individual through growth; third, its parts and whole are 'reciprocally dependent on the preservation of the other' (ibid). Note that these features of entities judged in accordance with teleological principles do not relate to the specific traits that individuals have adapted in relation to their environment. Ginsborg refers to these features as the primitive conditions that any individual must fulfil to be judged as an organism. Her reference to these conditions as 'primitive' is central for her interpretation of Kant's account of teleological judgment. She argues that our judgments of organisms are primitive insofar as they are derived from neither theoretical nor practical reason, they relate to the conditions that any experience must fulfil to be judged

as an organism.[65] This is different than discussions of teleology in contemporary biology which are concerned with the use of specific terms such as *function* or *purpose* (Breitenbach, 2009, p.45). Kant argues that our justification for conceiving of nature as including these entities is not derived from nature, rather it depends on a teleological principle that cannot be derived from experience. In this sense, the conditions for the judgment of organisms is prior (or primitive) to the investigation of the particular traits of organisms. Kant identifies the tenuous relationship between design and biology which biology treats as merely an empirical problem. According to Ginsborg, the problem identified by Kant's conception of teleological judgment is fundamentally conceptual, it relates to the requirement of viewing organisms *as if* they ought to possess certain traits:

> the empirical fact that an organism displays such-and-such a trait because that trait increased its ancestors' capacity to produce offspring, does not on its own entitle us to think of the animal as *designed* to have that trait, or more specifically, to claim that it *ought* to have it. (Ginsborg, 2015, p.330)

Kant's account of teleological judgment gets to the heart of the controversy that still persists in biology regarding the apparent design of biological phenomena. The predominant view in philosophy of biology is that biological functions are grounded in natural selection and are not derived from psychological notions of purpose, design and intention (Allen and Beckoff, 1995, p.612). If an organism possesses a functional trait, it does not entail that the trait is a product of design, yet, the problem of design cannot simply be cast aside in biology. For Ruse, without the metaphor of design biology 'would grind to a halt' (Ruse, 2003, p.285). Evolutionary explanations are only possible on the basis that the capacity for the experience of organisms in general is presupposed, however, justification for this knowledge is beyond the remit of biology. They cannot 'say anything about the epistemological reasons that enable us to pick out something as a purposively organised unity in the first place […], with which the Kantian conception of teleology is concerned' (Breitenbach, 2009, p.50).

The tendency to consider biological traits in accordance with purposive design has been discussed by Gould and Lewontin in their criticism of adaptationism. Adaptationism favours evolutionary explanations for the stabilisation of a trait within a

[65] This is a crucial aspect of Ginsborg's interpretation which is further discussed in Chapter Five (2.2). She describes the judgment of organisms as relating to an ought without a value to exemplify that it is not derived from rational principles and to show how defective organisms are not morally defective (Ginsborg, 2015, pp.251-4).

species; certain traits stabilise in a species because of the increase to fitness it gives to those individuals possessing the trait. Lewontin and Gould argue that it is misleading for biology to investigate nature on the hypothesis that *all* traits stabilise because of increased fitness to the species. They argue that some traits stabilise because of physical constraints. These are analogous to architectural constraints such as spandrels. Spandrels refer to the spacers in buildings that are required when curved walls cannot meet. Gould and Lewontin justify this analogy between traits and spandrels since 'we find them [spandrels] easy to understand because we do not impose our biological biases upon them […]. Since the spacers must exist, they are often used to ingenious ornamental effect' (Gould and Lewontin, 1979, p.148). That these spandrels are subsequently decorated demonstrates how the origin of a trait of an entity can be entirely different from its current use. Analogously, some biological traits may have originally stabilised because they were the by-product of other features of the organism; like the spandrels their current use may differ from the original reason for their existence; '[o]ne must not confuse the fact that a structure is used in some way […] with the primary evolutionary reason for its existence and confirmation' (Gould and Lewontin, 1979, p.153). By explaining the stabilisation of traits primarily in relation to increased fitness, adaptationism tends to overlook alternative explanations. For instance, Dennett has argued that in cases where adaptationism cannot currently explain a trait, this does not mean that such explanations will not be offered in the future; '[a]daptationist research always leaves unanswered questions for the next round' (Dennett, 1995, p.248).[66]

Gould and Vrba argue that adaptation should be considered as one mode under the broader category aptation (Gould and Vrba, 1998, p.65). Aptation includes both adaptations and exaptations, exaptations can be further subdivided into cases where a trait is previously adapted for another function, or they may have been non-aptive structures. A paradigm example of the former is that feathers were primarily adapted for thermoregulation, but were utilised in the exaptive capacity for flight. Examples of exaptations that are non-aptive are more elusive. One reason for this is that they are a

[66] This dispute shares a similar structure to the disagreements regarding Kant's antinomy of judgment. McLaughlin argued that Kant's prioritisation of mechanical explanations should be understood as Kant's commitment to the ideal that everything might eventually be explained in accordance with mechanism. Much like the adaptationist account, he argues the aspects of nature that cannot currently be explained in accordance with mechanism does not mean entail that an explanation will not be possible in the future. I argued that this could not have been Kant's view as he argued that it is inconceivable that mechanical explanations could be developed to replace these teleological explanations. See Chapter Four (2.2).

missing term in the taxonomy of evolutionary morphology, which means they do not feature in the way we think about biology. They argue that mutation at the genetic level has been accepted as non-aptive, '[b]ut we have not adequately appreciated that features of the phenotype themselves […] can also act as variants to enhance and restrict future evolutionary change' (Gould and Vrba, 1998, p.67). They argue that the current conviction of the supremacy of adaptationist explanations has resulted in an inability to comprehend the potential number of cases of exaptive traits. For these traits 'current utility carries no automatic implication about historical origin' (Gould and Vrba, 1998, p.68). Gould and Vrba reveal that the adaptationist model cannot correctly identify the historical origins of traits in all cases as it is blind to any other factors that may have contributed to the emergence of traits. The introduction of exaptations as a methodological term in biology allows us to consider how traits might not have been originally selected for on the basis of their current functions, they could have been selected for a different function or may not have had a function at all.

In contrast, Kant's account of the organism as the product of teleological judgment makes the stronger claim that it is impossible to establish knowledge of the historical origins of organic nature. Kant describes the investigation of nature from the perspective of historical origin as an archaeology of nature. It is 'a daring adventure of reason' (CJ 5:419). This natural archaeologist assumes that the maternal womb of nature arose from chaos, but this does not avoid the need to regard nature as governed by teleological principles. According to Kant, 'he must attribute to this universal mother an organization purposively aimed at all these creatures, for otherwise the possibility of the purposive form of the products of the animal and vegetable kingdoms cannot be conceived at all' (CJ 5:419-20). In this sense, Kant pre-empted how the possibility of viewing nature in accordance with design required us to attribute nature with a principle of organisation.[67]

This provides a different perspective on the relation between Kant's account of teleology and scientific naturalism. According to Zammito, '[t]he *third Critique*

[67] This offers support to Mensch's account of how transcendental idealism appealed to the biological sciences, specifically the principles of epigenesis. However, these appeals to scientific principles to explain the emergence of reason ultimately entailed that these principles were not reconcilable with transcendental idealism in their biological context. According to Mensch, '[e]pigenesis thus served as a resource for a *metaphysical* portrait of reason, even as it was denied determinate efficacy in the world of organisms' (Mensch, 2013, p.144). See Chapter One (1.2)

essentially proposed the reduction of biology to a kind of pre-scientific descriptivism, doomed *never* to attain authentic scientificity, to have its "Newton of the blade of grass"' (Zammito, 2006, p.748). In contrast to the idea that transcendental idealism reduces science to a mere descriptivism in opposition to scientific naturalism, Ratcliffe has argued that Dennett's explanation of understanding design through the metaphor of 'reading Mother Nature's mind' cannot be supported by scientific naturalism. Ratcliffe argues that Dennett's account requires a transcendental non-naturalistic ground. For Dennett, natural selection requires us to view nature as if it were designed; for us to regard nature as designed means we must regard it as the product of intentions. This intentionality disappears once we recognise that 'Mother Nature' can explain her selective procedure in terms of evolutionary processes which are not intentional. Nature is designed without needing a designer. Dennett describes natural selection as 'a scheme for creating Design out of Chaos without the aid of Mind' (Dennett, 1995, p.50). Dennett's account is meant to demonstrate how design in nature requires this intentional stance, whilst allowing for this stance to fall away once we possess knowledge of the nonintentional natural selective pressures that produce this design. Ratcliffe argues that Dennett does not recognise that it is impossible to explain away intentionality in this manner. According to Ratcliffe '[t]he intentional stance cannot be eliminated, circumvented or explained away and, insofar as Dennett's account conceptually presupposes the intentional stance, it is ultimately nonnaturalistic' (Ratcliffe, 2001, pp.37-8). Far from showing that transcendental idealism is non-scientific because of its opposition to naturalism, it reveals that Dennett's account requires a non-naturalistic standpoint. Ratcliffe suggests that we approach Dennett's account of intentionality from a Kantian perspective. For Kant, naturalism is an insufficient ground for us to judge nature in terms of final causes. Of course, Dennett is proposing that there is such a naturalistic basis; however, this presupposition is underdetermined. According to Ratcliffe, '[i]nstead of informing us about the structure of the world, he [Dennett] is inadvertently charting the constituting framework that renders a conception of the biological world possible' (Ratcliffe, 2001, p.42). The possibility of conceiving of nature in accordance with design presupposes that we can conceive of the world *as if* it is designed.

For both Dennett and Ruse, the fundamental issue concerns the ability to adopt or dispense with the metaphor of design. Their conception of metaphorical thinking as a requirement for natural selection that can then be dispensed with once the non-intentional

mechanisms have been uncovered is problematic. Dennett agrees that the original ability to perceive design in nature demands that we view nature in accordance with our own intentionality, but his account suggests that this intentionality disappears once we gain a better understanding of the mechanisms of natural selection. For Kant, this intentionality cannot disappear from the conception of the organism without entailing the inability to recognise our experiences of organisms as such. According to Breitenbach, 'on Kant's account, to consider something in nature as organic is already to view it teleologically' (Breitenbach, 2009, p.44). This means that if it is necessary that organisms are primarily conceived of in accordance with design, then it is also necessary to explain how the conception of the organism as the product of design can be replaced by a mechanical or non-teleological account.

2. Organisms without design

The distinction between man-made artefacts and organisms is still a pertinent topic in contemporary philosophy of biology. Nicholson identifies various disanalogies between organisms and artefacts that problematise the prevalent view of 'the machine conception of the organism' (Nicholson, 2012, p.669). The fundamental differentiating feature between organisms and artefacts is that artefacts have functions at both the level of their parts and their wholes, whereas organisms only have functions at the level of their parts. Taken as a whole, '[a]n organism does not have a function because its operation is not good for anything; it simply acts to ensure its continued existence' (Nicholson, 2012, p.671). Nicholson notes that the domestication of animals is potentially problematic for this account, as such organisms seem to display functions both at the level of their parts and their wholes. The organism's activity is hijacked by an external agent and subject to the purposes imposed on it by that external agent. It seems that in such cases, the domesticated organisms are also artefacts in some sense.

There are various points of similarity and dissimilarity that can be drawn between the accounts of Kant and Nicholson, Kant would agree with the need to distinguish between organisms and machines. As previously discussed, machines cannot repair or reproduce their parts or their wholes.[68] Their functions depend on the intentions of an entity that is external to the machine. However, Kant argues organisms must still be

[68] See Chapter Four (2.2)

considered *as if* it were the product of intentional design as this is the only way that we can regard the parts of the organism as existing for the sake of the whole. One fundamental difference between their accounts of organisms is that Nicholson argues that organisms are distinguished from artefacts ontologically rather than transcendentally. This is made possible by considering organisms in relation to thermodynamics. Of specific importance is the discovery that all matter possesses a '*universal tendency* toward the degradation of mechanical energy' (Prigogine & Stengers, 1984, p.115). Unlike other entities, organisms are open to their environments allowing them to maintain their organisation. Schrödinger describes this ability as '[a]n organism's astonishing gift of concentrating a "stream of order" on itself and thus escaping the decay into atomic chaos – of "drinking orderliness" from a suitable environment' (Schrödinger, 1992, p.77). Every part of an organism must replenish its orderliness from its environment, whereas for machines replenishment is specific to certain functions that they perform. According to Nicholson,

> This is why the fuel–food analogy is so misleading, and why the stability of a machine—despite its apparent dynamicity—ultimately resides in an unchanging material structure. In machines there is a specific 'inflow' and a specific 'outflow'. In organisms everything flows. (Nicholson, 2018, p.146)

It follows that conceiving of organisms as machines is misleading. Organisms are not designed in accordance with external plans, nor is their energetic openness to environments limited to certain functions. Organisms are better understood in relation to non-organic dissipative structures that tend to maintain order such as storm systems or eddies. According to Dupré and Guttinger, '[t]he organism, thus broadly construed, can then be seen as a stable eddy in the flow of interconnected biological processes' (Dupré and Guttinger, 2016, p.110). Considering organisms as more complicated manifestations of entities that do not require us to view them as the product of design offers support to the argument that organisms are also not designed. According to Nicholson, '[t]he striking thing about the order of all dissipative structures, including organisms, is that it arises in the absence of design' (Nicholson, 2018, p.159).

The virtue of Nicholson's account is that it provides an explanation for why it is not necessary to consider organisms as the product of design; however, this account creates a difficulty for distinguishing organic and non-organic dissipative structures. For instance, Kauffman has argued that the storm system on Jupiter known as 'the Great Red Spot' could be regarded as a living system:

> One can have a remarkably complex discussion about whether the Great Red Spot might be considered to be living – and if not, why not. After all, the Great Red Spot in some sense persists and adapts to its environment, shedding baby vortices as it does so.
>
> (Kauffman, 1995, pp.20-1)

Considering organisms as non-dissipative structures entails that organisms are not analogous to machines that are the product of external intentions. Instead they should be considered as more complex examples of non-intentional, non-organic stabilisations of dissipative structures. On the one hand, this is problematic for Kant's account of teleological judgment because it reveals that organisms are identical in kind to non-organic dissipative structures. On the other hand, Kauffman's comment that certain dissipative structures might be regarded as living can be supported by Kant's account of teleological judgment. Ginsborg has noted the virtue of Kant's account of teleological judgment is that it is applicable to non-organic entities such as storm systems. She argues that philosophical analysis of the principle of function 'should not rule out in advance that we might encounter non-biological phenomena for which functional characterizations turn out to be scientifically indispensable' (Ginsborg, 2015, p.344). Whilst she specifies that entities such as storm systems are inherently non-biological, the ability to conceive of them in terms of teleological judgment suggests that it is not possible to establish this clear distinction between biological and non-biological entities as both can be judged in accordance with final causes. Ginsborg explains that storm systems are different from organisms because the self-preserving character of storm systems is due to basic physical forces (Ginsborg, 2015, p.320). In contrast to Ginsborg, the reason we can judge storms systems in accordance with final causes is because the experience of them resembles the experience of organisms. Like organisms, non-organic dissipative structures do not display a final cause that is produced by the intentions or plans of an external source, rather its ability to be perceived in terms of final causes is because it is perceived as self-maintaining. It is both a 'cause and effect of itself' (CJ 5:371). Thermodynamics breaks down this distinction between living and non-living systems as the self-organising capacities of any entity should be explainable in terms of basic physical forces.

Some accounts of Kant have suggested if Kant had been aware of thermodynamics, he would have radically altered his discussion of teleological judgment. They argue that Kant would have realised that it was not necessary to view organisms as

governed in accordance with teleological principles. Thermodynamics provided the rule that allows for the manifest order of dissipative systems (or negentropic systems) to emerge from the broader context of global entropy. Roqué argues that as Kant was not aware of such a rule, he had to present mechanism and teleology of organisms in the context of regulative judgments: 'Kant regulates teleology to regulative judgment only because its peculiar form of recursive causality "unknown to us" could not be subsumed under a (mechanical) causal rule […] Nothing in Newtonian physics could provide such a rule' (Roqué, 1985, pp.108-9). This sentiment is also reinforced by Weber and Varela: '[t]he real "Newton of the grassblade" was not to be an individual person, but a historical convergence of philosophical and biological thinking' (Weber and Varela, 2002, p.121).

This argument that there is a compatibilism between Kant's account of teleological judgment and the contemporary ontological account of the organism is problematic for two reasons. First, Kant regarded our ability to engage in scientific enquiry as dependent on projecting a rational order onto nature in accordance with ideas. Scientific laws are not universal truths but regulative projections of order onto nature, hence it is not possible to provide a constitutive ontological account of the organism on the basis that we have discovered an appropriate constitutive ontological law of nature. Thermodynamics can only provide an ontological account of organisms under an inherently non-Kantian account of the relationship between epistemology and metaphysics. Under such an account, space and time could not be limited to conditions of the subject, but rather conditions of entities independent of experience. Second, if Kant's argument that we require teleological judgment for the comprehension of organic entities is accepted, then the account of organisms as negentropic entities does not necessarily entail that we do not also need to view them in accordance with teleological judgment to first comprehend them as organisms.

In summary, this section has examined the status of design in contemporary philosophy of biology. It was shown that Dennett's appeal to design requires a non-natural source of purposiveness to explain how nature can be approached from an intentional stance. According to Rattcliffe, Kant's account of teleological judgment is a suitable candidate. This is strikingly similar to Ruse's interpretation of Darwin which suggested the purposiveness of organisms could also be supported by Kant's conception of final causes. Neither Ruse nor Dennett consider how this demonstrates that their accounts require a fundamentally non-naturalistic ground. The criticism of adaptationism

raised by Gould and Lewontin was also examined. They argue adaptationism assumes that the current function of a trait is the reason the trait originally stabilised. This is misleading because many traits originally emerged in response to different environmental pressures; for instance, feathers primarily served a thermoregulatory function. Moreover, some traits are aptive and do not increase the fitness of the organism at all. Kant's conception of teleological judgment entails the stronger claim that we can never justify the emergence of function in accordance with nature as he describes such attempts as 'a daring adventure of reason'. Finally, this section examined Nicholson's denial of the design of organisms. He argues thermodynamics has resolved the need to understand organisms as products of intentional design analogous to machines, instead organisms are better understood in relation to non-organic dissipative structures such as whirlpools. This resolves the problem of natural design at the cost of sufficiently demarcating between the conditions of organic and non-organic entities.

4. Problems with defining the organism in contemporary philosophy of biology

This final section surveys problems regarding definitions of the organism in contemporary biology. The concept of the organism is central to biology, yet there is little consensus on the definition of what constitutes an organism or biological individual. Many accounts distinguish between technical and common-sense understandings of the organism. We all seem to have a common-sense awareness of organisms, yet when this awareness is subject to further scrutiny the distinction between organic and inorganic entities loses its clarity. According to Okasha and Clarke:

> We know that dogs are organisms, while their tails are not. […] Surely, then, any attempt to claim that species and organisms are problematic notions, calling out for the attention of philosophers, is just an example of professionals making work for themselves? The truth […] is that scientists really do encounter these problems, and the apparent obviousness of the intuitive concepts just makes our opening questions all the more pressing.
>
> (Okasha and Clarke, 2013, p.55)

Darwin assumed that the ability to identify organisms and species was common knowledge amongst naturalists and required no special treatment (Darwin, 2003, p.122) Developments in biology since Darwin have revealed that many entities which appear to

be organisms cannot be understood in terms of this common-sense account. For instance, when members from two separate species form a symbiotic mutualism that increases fecundity for both species, it can become difficult to identify the boundaries between these individuals, or to know how many individuals there are. These issues are important because 'if we cannot agree on the boundaries and number of individuals, we cannot obtain meaningful notions of populations. Without clear and non-controversial population structures, assessing the evolution of these systems is difficult at best' (Bouchard, 2008, p.633).

There are various competing accounts for definitions of biological individuality in contemporary philosophy of biology. Clarke identifies thirteen different definitive features that philosophers of biology have demarcated as conditions for biological individuals (Clarke, E., 2010, pp.315-6). Pepper and Herron have supported the co-existence of many concepts of the organism. Alternative organism concepts tend to refer to entities that express some degree of functional integration and genetic homogeneity. In this sense, the distinction between organic and non-organic entities is not a categorical difference in kind, but a continual difference in degree (Pepper and Herron, 2008, p.624). This section considers some cases which are particularly problematic for establishing a single explanation of biological individuality.

The Pando forest in Utah has been regarded as the largest single living organism. Above the soil, each tree looks separate from every other, yet, beneath the soil the trees all share a common-root structure. These apparently separate quaking aspen trees are clones formed by multiple runners fusing underground and growing up toward light (Grant and Mitton, 2010). The reasons for identifying the Pando forest as a single biological individual is that it is genetically homogenous and has distinct spatial boundaries, yet these boundaries are not visible above the soil. In contrast, there are various examples of symbiotic relationships between genetically and spatially distinct organisms forming relationships that increase the fitness for one or both sides of the party. For instance, consider the symbiotic relationship between the bobtail squid and the bacteria *vibrio fischeri*. The squid provides protection for the bacteria by housing it in cavities in its body (called photophores). The bacteria protect the squid against predators as they possess the capacity for bioluminescence. The predators of the squid hunt by looking for shadows that the squid casts, but in this symbiotic relationship the squid is bioluminescent and does not cast a shadow. The two organisms are genetically distinct,

yet functionally integrated in a way that increases fitness for both parties. The functional integration of the squid and the bacteria have been 'selected for' together as a whole via natural selection. In this sense, the squid and bacteria could be regarded as a single 'superorganism'. The trait that increases fitness is bioluminescence which emerges only at the level of the symbiotic relationship. The bacteria become bioluminescent through the mechanism of quorum sensing. This means that when the bacteria reach a certain density, the trait of bioluminescence is activated. Whilst the genes required for bioluminescence are located in the bacteria, the bacteria do not generally reach sufficiently high densities for bioluminescence outside of the squid's photophores. According to Bouchard,

> if the bacteria alone does not often glow, and the squid alone cannot, who or what is bioluminescent and what benefits by being bioluminescent? Let us assume for a moment that we have an emergent trait (i.e. not reducible to single genome). What is the biological individual bearing that trait if not the system comprising both squid and bacteria? (Bouchard, 2010, p.632)

Bouchard considers the different ways that biological individuation could be applied to the symbionts. As there are 1 billion bacteria and 1 squid we could say there are 1,000,000,001 biological individuals. Alternately maybe there are two biological entities (1 squid and 1 vibrio superorganism) or maybe there are 1,000,000,003 (1 squid, 1 billion vibrio, 1 vibrio superorganism, and 1 squid/colony emergent superorganism). In the context of this debate what is important is the need for biologists to recognise the diverse ways that biological entities can respond to selective pressures—symbiotically or otherwise. These kinds of symbiotic relationships are not uncommon in nature, for instance '[i]n contrast to the squid light organ, which is colonized with only a single symbiont, the mammalian intestine is inhabited by more than 400 species of bacteria. Similar to squid, mammals acquire their microflora from the environment' (Hooper, 2004, p.130). It has been estimated that there are ten times more microbes living inside and on our body than our somatic and germ cells (Turnbaugh et al., 2007).[69]

It has also been argued that the conception of the organism should be extended to include the functional relationships that biological entities develop in relation to their

[69] The next chapter examines how the continuity theory of immunology explains how the organism is an entity that possesses an immune system which monitors both endogenous and exogenous entities. If tolerated by the immune system, these entities are all considered as part of that organism. See Chapter Five (3.3).

environments.[70] For Turner, the abiotic mound of a *Macrotermes* colony of termites ought to be considered as an extended organism. The mound is not biotic, but it 'is an organ of extended physiology that promotes the colony's respiratory gas exchange' (Turner, 2013, p.224). This is necessary for the symbiotic relationship that the termites have formed with fungi brought into the mound that digest cellulose into simpler sugars that the termites then re-consume. Turner's argument is an extension of Dawkins account of the extended phenotype in the sense that an organism's behaviours and other activities are produced from the genes of that organism and hence are part of that organism. According to Turner, 'every organism is, in a sense, an extended organism, unable to exist without imparting a kind of physiology to its surroundings as well' (Turner, 2013, p.236).

Both Turner and Bouchard support the idea that we can measure biological change at the genetic level, yet they oppose the notion that we could understand the potential functions made possible by genes by focusing solely on this level. It would not be possible to appreciate why the bobtail squid has the capacity to develop light organs unless we consider the symbiotic relationship between the squid and bacteria. According to Turner, 'genes really have no meaningful existence outside the functional environments that carry them into the future' (Turner, 2004, p.347). Bouchard disagrees with the idea that these non-biological components of organisms could be understood in the same way as biotic aspects of an organism. He argues that '[i]f an evolving individual may be in part nonbiological, then it is possible that its evolution will not be fully accounted for via differential reproductive success, since the adaptive external structures that Turner describes cannot be passed on genetically' (Bouchard, 2008, p.567). There are many cases where extended physiologies could be utilised by subsequent generations. For example, a burrow can become part of the short-term extended physiology of an organism whilst it inhabits a burrow that it has constructed, but there are also cases where a burrow can become a persistent part of the functional environment 'where the same burrow was inhabited by many generations of burrow-diggers' (Turner, 2004, p.345). The problem here is not whether the burrows or mounds have increased the fecundity of their dwellers, but whether these increases in fecundity can be accounted for genetically. The difference between the biological and non-biological components is that when non-biological

[70] The recognition of the need for a greater understanding between biological entities and their environments is called 'niche construction'. For an account of the significance of niche construction for philosophy of biology, see (Odling-Smee et al., 2003)

components are ‘inherited’ by subsequent generations, the genes of the current generation have not directly contributed to the construction of this environment.

This is relevant to the distinction between organisms and artefacts discussed in previous sections of this chapter. In this context, the issue is not the justification of organisms as analogous to artefacts but rather whether the artefacts that organisms produce can be conceived of as part of the organism. Symons has suggested that artefacts and organisms are ontologically distinct. According to Symons, ‘[t]he factor that determines the persistence condition of the organism is the functional interdependence […] and not the origin of that interdependence’ (Symons, 2010, p.245). This distinction between organisms and artefacts does not relate to the design or plan of an artefact as external as it did for Kant and Paley. For Symons, both genetically engineered organisms and organisms that are artificially selected in virtue of a trait for our purposes cannot be considered as artefacts. These changes are introduced artificially, but the changes are functionally interdependent and cannot be separated from the organism. In contrast, a pacemaker is an artefact because it does not depend on the other functions of the body. When an individual with a pacemaker dies, ‘the pacemaker will still be a pacemaker and could possibly even be reused in another body’ (Symons, 2010, p.244). According to this account, entities such as termite mounds and burrows would also be considered as artefacts insofar as they do not become functionally integrated with organisms. They can exist independently from the organisms that first created them and can be inhabited by future generations. This is analogous to the pacemaker that could be transplanted to another body. Hence, Symons’ distinction between artefacts and organisms offers support to the argument that the termite mound could not be considered as an organism because it is not completely functionally integrated with the termite colony. However, the *vibrio fischeri* that are housed in the light organ of the bobtail squid would also be understood as artefacts for the same reason. The squid expels most of the bacteria daily, so they also do not become fully integrated with the squid. According to Bouchard, this is ‘most likely to reduce the possibility that the symbiont would evolve a pathogenic response as many other Vibrio have done’ (Bouchard, 2010, p.631).

These examples demonstrate that the ability to offer a single definition of the organism is far from clear. This has led to doubts regarding the traditional conception of the organism as a paradigm individual. Bouchard has criticised Van Inwagen’s metaphysical conception of organisms as possessing a special causal relationship which

the biologist is responsible for explaining. Bouchard argues that Van Inwagen is sidestepping the issue of vitalism for biological composite entities 'by putting in the hands of biologists the problem of figuring out the nature of this special causal relationship' (Bouchard, 2013, p.244) *Pace* Van Inwagen, biologists have not generally found this special causal relationship. Instead biologists have found that organisms generally are not paradigm cases of this form of individuality at all.

In summary, this section has surveyed some problems surrounding definitions of biological individuals in contemporary philosophy of biology. It revealed how genetic homogeneity can explain why biological individuals such as the Pando forest of quaking aspen can be regarded as a single biological entity, but genetic homogeneity cannot sufficiently explain how entities that form symbiotic relationships could also be regarded as biological individuals. In cases such as the symbiotic relationship between the bobtail squid and *vibrio fischeri*, the squid has developed light organs in response to the presence of the bacteria. This demonstrates how entities with distinct genetic lineages can become functionally integrated with one another. Turner argued that our understanding of functional integration should be extended to abiotic structures that organisms produce. The abiotic mounds created by termite colonies should be regarded as an extended physiology of the organism. The mound building behaviour of the colony shows how the colony possess the genes to turn their environment into an extended physiology. All three cases recognised the importance of genetics for understanding biological individuals. This was considered in relation to the discussion of artefacts and organisms. Symons argued that the distinction between artefacts and organisms was ontological. An organism is a functionally interdependent unit. When applied to these examples of biological individuals, this revealed that both Turner's account of the extended organism and Bouchard's example of the symbiotic relationship between the bobtail squid and its bacteria would not be considered as organisms as neither have achieved complete functional interdependence.

Conclusion

This chapter has examined some of the influences that contributed to the development of Darwin's *Origin*. It began by considering Kant's influence on Whewell's account of

biology. Whewell extended Kant's account of the purposiveness of nature to suggest that if any part of nature can be understood as exhibiting a teleological plan, then this is evidence of the design of nature in accordance with God's grand design. In contrast, Kant argued that we cannot regard nature as the source of design, instead our ability to view nature teleologically only related to our capacity to judge nature as such. Darwin's account was not influenced by Whewell's conception of biology, instead he drew from Whewell's account of the consilience of nature discussed in the previous chapter. I examined the influence of Whewell and Herschel on Darwin's arguments from common ancestry and natural selection. The argument from common ancestry was more closely related to Whewell's conception of *vera causa* as derived from the principle of consilience, whereas Darwin's argument for natural selection was based on the analogy with artificial selection. Herschel's account of *vera causa* principles was based on analogical reasoning. I argued Darwin was attempting to satisfy the methodologies of both Herschel and Whewell.

Section two critically examined Darwin's analogy between artificial and natural selection. The received interpretation of Darwin is that Malthus' influence in combination with artificial selection inspired Darwin's account of natural selection. In contrast, Richards argued that Darwin's appeal to artificial selection is not an analogical argument because there are too many incompatibilities between natural and artificial selection. Following this, I examined Ruse's interpretation of Darwin which argued the purposiveness of organisms is compatible with Kant's account of teleological judgment. Whilst Darwin was unaware of Kant's discussion of teleological judgment, Ruse argues that Kant's account of the design of organisms—as emerging from our heuristic capacity to judge nature in accordance with purposes—is consistent with Darwin. Ruse's interpretation overlooks important differences between the philosophies of Kant and Darwin. For instance, Kant's account of teleological judgment as a heuristic does not entail that it is possible to conceive of organisms in a non-teleological manner. Teleological judgment is a necessary condition for the possibility of conceiving organisms. Another significant difference is that Kant denied that organisms could be understood as artefacts. This difference was examined in the context of Paley's influence on Darwin. I argued Kant would have opposed Paley's thought experiment that finding a watch on a heath was evidence for the divine design of nature. Kant distinguished

organisms from artefacts on the basis the that former are judged to possess a formative force, whereas the latter possess a motive force.

Section three considered the status of design in contemporary philosophy of biology. I examined Gould's and Lewontin's criticism of adaptationism on the basis that it assumes that all traits stabilise because they increase fitness for a species. In contrast, many traits stabilise because of physical constraints which are comparable to architectural constraints called spacers or spandrels. The underlying issue is that the origin of a trait cannot always be accurately identified solely in terms of increased fitness. Moreover, Ratcliffe argued that Dennett's adaptationism requires a non-naturalistic ground for his account of the intentional stance. This revealed a close similarity between the accounts of Dennett and Darwin as it has been argued that both are offered support by Kant's philosophy. Importantly, this support comes at the cost of revealing that their theories require a non-naturalistic ground.

I also considered the argument that thermodynamics provides the basis for an alternative conception of organisms that does not require design. Nicholson argued that viewing organisms as designed promotes the machine conception of the organism. Organisms are not similar to machines because machines have an unchanging material structure, whereas organisms are constantly changing every aspect of their material structure. Organisms are more similar to non-biological dissipative structures such as storm systems. Regarding organisms as more complex versions of non-organic dissipative structures results in an inability to distinguish between living and non-living dissipative structures. For instance, Kauffman argues that it is possible to consider storm systems such as the Great Red Spot on Jupiter as a living system. Kant's account of teleological judgment can offer support to this as he only exposes the conditions for conceiving of an entity teleologically without ruling out what kinds of entities could be judged in accordance with these conditions. Overall, the account of organisms as emerging from non-biological dissipative structures is problematic from the perspective of transcendental idealism. From this perspective, the laws of thermodynamics could only be understood as a regulative projection onto nature, hence it could not provide a constitutive foundation for the ontological conditions of organisms.

This chapter finally examined difficulties relating to contemporary definitions of biological individuals. I examined how conditions of biological

individuality such as genetic homogeneity and functional integration have offered alternative accounts of the boundaries and number of biological individuals. The Pando forest is regarded as a single biological individual in virtue of its genetic homogeneity. In contrast, the bobtail squid and its symbiotic relationship with *vibrio fischeri* are also regarded as a single biological individual because of their physiological functional integration. Whilst this biological individual consists of two separate genetic lineages, they have been selected for at level of their symbiotic relationship. This reveals that genetic homogeneity is an important feature of biological individuals, but it is not sufficient for demarcating biological individuals. I considered the argument that the conception of biological individuality should be extended to include the structures that organisms build. This focused on the example of termite mounds that function as a lung for the termite colony. Turner argued that the mound should be considered as part of the extended physiology of the colony. Although the mound is abiotic, it is a product of the behaviour of the termites that should be understood as emerging from of the genome of the colony.

Chapter Five: Appeals to Kant's critical philosophy in contemporary philosophy of biology

Introduction

Scholarship examining Kant's influence on philosophy of biology generally focuses on the influence of the Third *Critique*. This chapter examines how contemporary philosophers of biology have appealed to various aspects of Kant's critical philosophy in support of their accounts. The underlying issue is that these appeals to Kant have tended to isolate aspects of his critical philosophy from the broader context of transcendental idealism. In this sense, the following discussion is developing from Zammito's concerns regarding the incompatibility between transcendental idealism and naturalism discussed in previous chapters, but this does not entail that Kant's philosophy has not been a source of influence for these accounts. In contrast, I argue that these appeals to Kant's philosophy need to be critically examined to appreciate both how Kant has influenced these theories and to identify the specific tensions that arise between Kant's philosophy and these contemporary philosophers of biology. This does not only reveal the points where these accounts have transgressed the limits of Kant's critical philosophy, but also explores how transcendental idealism could offer support for these theories.

In this chapter, three different cases are discussed where Kant's philosophy has been explicitly appealed to in support of different aspects of their accounts. First, I examine Dupré's appeal to Kant's conception of morality as a way of supporting his own account of biological freedom. His argument that the goal directed behaviours of humans have led to shared projects at the societal level that have increased the fecundity of individuals and species shares some similarities to Kant's account of freedom. Both emphasise that humans should be considered as the source of their own agency. Dupré interprets Kant as developing a deterministic account of nature. I examine Kant's compatibilism between freedom and determinism which argues that both the laws of nature and the laws of freedom are generated from the faculty of reason as regulative principles that guide nature. The compatibility between these two accounts of causality is made possible by Kant's distinction of objects of appearance from objects in themselves. This is a source of incompatibility between Kant's account of freedom and Dupré's conception of biological autonomy. Finally, this section considers the relation between

Kant's moral philosophy and his political philosophy. Kant's account of political philosophy as governed by the moral law offers a foundation for how society can be developed in accordance with progressive principles. I argue that this aspect of Kant's philosophy could offer potential support to Dupré's discussion of the fact/value distinction in philosophy of science.

The second section discusses appeals to Kant's account of teleological judgment in support of contemporary accounts of biological autonomy. The Kant-inspired account of the organism is undergoing a resurgence in contemporary biology which emphasises the holistic conception of living systems. This appeal to Kant's philosophy is potentially misguided as Kant's account of teleological judgment must be understood in the broader context of his critical philosophy. Kant approached physical teleology from the context of the architectonic structure of transcendental idealism. Physical teleology was inherently related to our capacity for teleological judgment in its moral context. This reverses the relation between biology and freedom as it is generally conceived by philosophers of biology. For Kant, biology was not the ground for freedom, rather freedom was the ground for conceiving of natural entities teleologically. This argument is compared with other interpretations of Kant's account of teleological judgment that do not consider the relationship between moral and physical teleology. This reveals that Kant's critical philosophy can be understood as offering an alternative account of consilience. For Kant, consilience should be understood as a relation between *faculties* rather than *facts*.

The final section examines Tauber's claim that Kant was significantly influential on the development of immunology. He argues that Kant's primary influence on the development of immunology was his conception of the self as embodied and possessing self-knowledge. This section explores how the conception of the immune-self fallaciously equivocated Kant's account of the self as the transcendental unity of apperception with the biological embodied conception of the self. It also examines how immune identity has changed to the point where it no longer requires a fixed self at its core. In contemporary immunology, Pradeu's continuity theory argues the immune self has been replaced with a conception of the organism as inseparable from the biological entities that are continuously tolerated by immune policing mechanisms. This is supported by recent research which suggests parasitic helminths have exerted a selective pressure on our genome and that stool transplantations can help re-establish normal functionality in the

human gut microbiome. Finally, Kant's account of the organism as the product of teleological judgment is compared with Pradeu's conception of physiological individuality.

1. Kantian morality and biological freedom

Specific interest has been focused on humans in biology as '[t]he human individual is idiosyncratically worthy of respect and moral treatment' (Clarke, E., 2010, p.313). This idea that humans are in some sense unique because of their idiosyncratic worth is based on their capacity for autonomy and freedom. This has also been raised in the context of the legal individuality that humans possess. The need to separate the legal and biological senses of individuality has been noted by Godfrey-Smith: '[m]aybe we should say different things in different contexts. Monozygotic human twins deserve two votes in elections, but perhaps they form a single unity in another sense' (Godfrey-Smith, 2014, p.68). The recognition that the moral and legal status of humans needs to be separated from our biological identity resonates with aspects of Kant's moral and legal philosophy. His accounts of autonomy, freedom and respect are primarily developed in the context of his moral philosophy.

This section considers Dupré's account of biological freedom and his appeal to Kant's account of agency. Dupré appeals to Kant's conception of freedom but rejects the broader metaphysical commitments of Kant's account. He interprets Kant as a causal determinist about the laws of nature. *Pace* Dupré, I argue Kant is a causal determinist at the level of appearances, but this determinism cannot extend to knowledge of the laws of nature. The transcendental condition for the possibility of freedom requires that knowledge of natural laws cannot be regarded as a complete deterministic account of nature. Following this, I consider how Kant's political philosophy—as developing from the principles of his moral philosophy—can offer support to the idea that biological research should develop toward socially progressive research that offers support and protection for citizens. This is implicit in Dupré's conception of science, but it cannot be sufficiently justified in accordance with biological naturalism alone.

1. Dupré's account of biological freedom

Dupré has considered the similarity between his own account of freedom as emerging from biological processes and Kant's conception of freedom. He is careful to avoid any possible implication that would commit his account to the broader metaphysical tenets of Kant's philosophy. In this sense, it would be misleading to suggest that Kant had influenced Dupré's conception of biological autonomy; rather there is a similarity between Kant and Dupré in regard to their conceptions of agency. According to Dupré, 'Kant's account of human action points in the right direction in which to look for this final ingredient of an account of human autonomy' (Dupré, 2001, p.179). Kant's philosophy is in the right direction because it is amenable to showing how humans can direct their activities toward their own goals. The impact that these projects have on our lives cannot be understood if we limit the focus of biology to genetics. In this sense, the niches that organisms construct must be taken into account for a better understanding of biological development. Dupré considers the emergence of hospitals and schools as examples of entities emerging from goals at societal levels that have contributed to both the extension of our lives and potential skills we can learn. We remain blind to the biological impacts of such entities under a reductive genetic biological account (cf. Dupré, 2012, p.282).

In relation to the various conceptions of biological individuality discussed in the previous chapter, Dupré's account is similar to Turner's account of the extended organism insofar as both suggest that the structures that biological entities construct from their environment should be regarded as relevant for our understanding of biological entities. There are two important distinctions to be made between their accounts. First, for Turner the structures that organisms construct such as termite mounds should be considered as an extension of the physiology of the organism. Second, Turner emphasises that his account is still compatible with a genetic account of the organism, albeit as inclusive of the extended physiologies that are (on his account) part of that organism.

Dupré distinguishes his account from Kant's on the basis that his conception of autonomy is not a 'rationally grounded canon of morality that constitutes an action as free or unfree' (Dupré, 2012, p.291). Instead, he argues that the difference between free and unfree actions should be understood in terms of 'a spectrum of degrees of causal efficacy' (ibid). *Pace* Kant, this spectrum of causal efficacy does not require an alternative kind of causality to account for freedom in opposition to the causality that governs nature more generally. For Dupré, the rejection of determinism at the ontological level entails that the

causal capacities at the level of human activity can be understood as the 'densest concentration of causal capacities, or causal powers, in our experience' (ibid).

The difference between the accounts of freedom developed by Kant and Dupré is that the former did not think that we could experience freedom as a spatiotemporal phenomenon. The possibility of freedom was established by revealing that the apparent determination of appearances was the product of the ideal of reason that demanded unity among experiences rather than revealing that this unity related to entities that exist independent of perception. According to Kant '[a]ll manifoldness of things is only so many different ways of limiting the concept of the highest reality […] [T]his does not signify the objective relation of an actual object to other things, but only that of an **idea** to **concepts**' (CPR A578/B606). Transcendental idealism entailed that at the level of ideas, enquiry must be considered as indeterminate rather than relating to objects in themselves. In the context of Kant's theoretical philosophy, he appealed to causal determinism at the level of the appearance of objects, but he denied that this determinism at the level of appearances could be regarded as culminating in a constitutive understanding of reality as a totality. According to Kant, for 'the **concept** of all reality, reason only grounded the thoroughgoing determination of things in general, without demanding that this reality should be given objectively, and itself constitute a thing' (CPR A580/B608). Both Kant and Dupré agree that laws of nature are not ontologically causally determined. Yet Kant argues that this does not demonstrate that we do not need a regulative conception of laws for the possibility of scientific enquiry.

2. Determinism and the Second Analogy

Kant explains how experience must be understood as governed by efficient causation in the Second Analogy. In cases of efficient causation, the cause always precedes the effect. Efficient causation must be understood in terms of the temporal distinction between the cause and the effect. This does not mean that all cases of successive experience are manifestations of objective succession. Kant explains this through the examples of seeing a ship going down a stream and viewing a house. In the former case, the appearance of the ship going down stream requires that there was a previous perception of the ship further upstream. According to Kant 'it is impossible that in the apprehension of this appearance the ship should first be perceived downstream and afterwards upstream' (CPR A192/B237). This makes it possible to say that something has happened because the

subjective experience is also objective insofar as it is possible to say something about the object. We can establish a rule which determines the experience in relation to the temporal order of appearances. In contrast, the experience of viewing a house does not depend on any specific ordering of successive appearances as the different features of the house can be viewed in multiple ways. Although the experience of the house is successive, it is not possible to discover a rule for the experience of viewing a house that determines our appearance in accordance with the temporal order of those appearances. The experience of a house does not reveal to us any change in the object of appearance. To be clear, the necessity that Kant attaches to objective succession does not pertain to the lapse in time, but to its temporal ordering. Kant argues that even in cases of efficient causation where the cause is simultaneous with the effect, such as a stove heating a room or a ball making a dent on a pillow, we are still able to derive the rule that makes it possible to view such experiences as objective. According to Kant, 'it is the **order** of time and not its **lapse** that is taken account of; the relation remains even if no time has elapsed.' (CPR A203/B248).

Dupré characterises Kant as advocating a deterministic philosophy that 'could be deduced a priori from the possibility of knowledge' (Dupré, 1993, pp.176-7). In the context of the Second Analogy, this characterisation is correct. Moreover, Kant argues that the role of the understanding in relation to nature is not restricted to merely establishing rules through the comparison of appearances, rather 'it is itself the legislation for nature, i.e. without the understanding there would be no nature at all' (CPR A127). This essential connection between the faculty of understanding and the laws of nature should not be regarded as extending the scope of the understanding to include knowledge of the laws of nature independent of appearances. Rather it is the reduction of knowledge of nature to appearances. There are two different senses that the laws of nature can be understood in Kant's philosophy. First, laws corresponding to the pure categories that are necessary for the possibility of experience. Second, general scientific laws of nature relate to regulative ideas that do not directly correspond to objects of experience, rather they are principles that are projected onto nature by reason as guidelines that direct enquiry. As previously discussed, Kant describes the way that ideas provide guidance for concepts as a form of *focus imaginarius.* The *focus imaginarius* is intended to demonstrate the necessary illusion that arises when concepts extend indeterminately in relation to the guidance of the unconditioned regulative principles of reason.[71] The only way to avoid

[71] See Chapter Three (2.1)

this illusion resulting in deception is to expose how these projections are not 'shot out from an object lying outside the field of possible empirical cognition' (CPR A644/B672). For Kant, the systematicity that guides experience cannot be understood as relating to objects in themselves, but rather as emerging from the demand of reason to impose the greatest possible unity on experience.

3. Kant's account of freedom as the compatibilism between compatibilism and incompatibilism

The demarcation of things in themselves from objects of appearance preserved the possibility of freedom. According to Kant, 'if appearances are things in themselves, then freedom cannot be saved' (CPR A336/B564).[72] In the context of practical reason, we must consider ourselves as governed by an entirely different kind of causal necessity. The account of causal necessity that Kant developed in his theoretical philosophy referred only to efficient causation under the conditions of appearances. This is not applicable in the case of practical reason because practical reason is not limited to the conditions of appearances. According to Kant,

> [natural necessity pertains to the subject] only so far as the determining grounds of any action of the subject lie in what belongs to the past and is no longer in his power; in this must be counted also his already performed acts and his character as a phenomenon as this is determinable for him in his own eyes by those acts. But the same subject, which, on the other hand, is conscious also of his own existence as a thing in itself, also views his existence *so far as it does not stand under temporal conditions*, and himself as determinable only by laws which he gives to himself through reason.
> (CPrR 5:97)

The relation between practical reason and time was previously discussed in the context of the two-world and two-aspect interpretations of Kant. It was argued that Allison's two-aspect interpretation separated causes from reasons on the basis that actions governed by practical reason can never be understood as a proof of freedom, but rather freedom must be presupposed to understand how it is possible to formulate rational maxims to guide enquiry. In contrast, the two-world interpretation argues that freedom constitutes another kind of causality directed toward ourselves as noumenal agents. Clearly, Kant does consider freedom to relate to a different kind of causality. According to Kant, '[t]he

[72] This distinction between appearances and objects was a crucial aspect of Kant's response to Hume discussed in Chapter Two (2.2). I argued that Hume's influence on Kant's philosophy should not be restricted merely to Kant's theoretical philosophy, but rather should be considered as also serving as the ground for the development of Kant's moral philosophy (cf. CPrR 5:101)

concept of causality as natural necessity, unlike the concept of causality as freedom, concerns only the existence of things as far as it is determinable in time, and consequently as appearance in contrast to their causality as things in themselves' (CPrR 5:94).

Wood describes the compatibility between freedom and nature in Kant's philosophy as 'the compatibility of compatibilism and incompatibilism' (Wood, 1984, p.74). These two forms of reasoning are compatible so long as we understand that one cannot encroach on the domain of the other. The essential difference is that freedom has no relation to intuitions. Kant argues that the entities that are central to practical reason (freedom, immortality, and the soul) are pure rational concepts; 'no corresponding intuition can be given and consequently no objective reality can be found for them in a theoretical way' (CPrR 5:134). As these objects are not given in intuition, they are necessarily non-spatiotemporal. Thus, the grounds for claiming a compatibility between freedom and nature resides in Kant's argument that the determinism of nature only relates to objects of appearance and not objects as they are in themselves.

This helps us to understand why Kant developed his account of freedom as entirely distinct from the temporal conditions that determined entities understood through theoretical reason. When we act in accordance with our inclinations we surrender our autonomy to past events that reduce our agency to nothing. In other words, we subject ourselves to the determination of efficient causation because the reasons for our actions can only be understood as efficiently determined by previous temporal events. This is consistent with Kant's distinction between hypothetical and categorical imperatives. Hypothetical imperatives require that the means and ends of an action are temporally distinct. According to Kant,

> all imperatives command either *hypothetically* or *categorically*. The former represent the practical necessity of possible action as a means to achieving something else that one wills […] The categorical imperative would be that which represented an action as objectively necessary of itself (G 4:414)

Through the categorical imperative, it is possible to formulate maxims that govern our actions in which the end of an action is not temporarily distinct from the means to achieve that end. In other words, the means and the ends of a categorical imperative cannot be distinguished in either the order or the lapse of time. In this sense, such maxims are universal because they cannot be influenced by any temporal factors.

Kant's distinction between theoretical and practical reason as the basis of transcendental idealism is indicative of deeper tensions between transcendental idealism and naturalism. For instance, many explanations for the emergence of morality in contemporary philosophy of biology presuppose that there must be a naturalistic explanation. Hull associates the idea of a specifically human nature with ethics and morality. The concept of legal right is premised on the notion that we have a high degree of similarity with one another. Hull argues that this assumption is inconsistent with our current biological understanding: '[a]ny ethical system that depends on all people being essentially the same is mistaken. If we have rights, we must have rights even if we are not all basically the same' (Hull, 1989, p.2). The theory of natural selection depends upon diversity and variability both within and between species. Biology reveals to us that all organisms and traits are contingent. If there is a universal human nature, then it is grounded on the principle of variation that humans share with all biological species. According to Hull, '[*w*]*hich* variations characterize a particular species is to a large extent accidental; *that* variation characterizes species as such is not' (Hull, 1989, p.12).

Hull is correct to identify this tension between Kantian morality and biology. Kant's separation of freedom from temporality requires that we view the source of our action as outside of time, and thus outside of nature. For Kant, moral agents must consider themselves as 'a lawgiving member of the universal kingdom of ends' (G 4:438). In this sense, rational agents are homogenous with one another insofar as they possess autonomy. Kant sets 'the principle of the **autonomy** of the will in contrast with every other, which I accordingly count as **heteronomy**' (G 4:433). Like Hull, he was also aware that empiricism could only result in knowledge of an essentially contingent kind in relation to morality. Hull was merely cautious of deriving moral principles from contingent conditions, whereas Kant denies any such possibility. Practical reason derives 'its concepts and laws from pure reason, to set them forth pure and unmixed, and indeed to determine the extent of this entire practical or pure rational cognition' (G 4:411). When the faculty of reason is not the source of an action, the action cannot be considered as moral. For any finite rational being, action can be caused by either the faculty of desire or the faculty of reason. We can be inclined toward actions that correspond to a need. However, if we act upon this inclination, then the cause of that action is necessarily a contingent state of affairs related to phenomenal experience; not to reason. An action caused by inclination is heterogeneous and contingent as it is caused by something outside

of itself. It does not signify a moral action but rather a '*pathological* interest in the object of the action' (G 4:414). The relationship between moral action and theoretical knowledge is antipodal. Theoretical knowledge is only possible on the basis that intuitions and concepts are schematised. According to Kant, the categories 'do not have any use at all if they are separated from all sensibility' (CPR B305). In contrast, practical reason has no relation to experience as the maxims that form categorical imperatives have no relation to intuitions (CPrR 5:65). Hull's commitment to biological naturalism entails that he cannot conceive of any appropriate grounds for concepts such as homogeneity and autonomy within the remit of naturalism. Hull is left with the following conclusion:

> Although I feel uneasy about founding something as important as ethics and morality on evolutionary contingencies, I must admit that none of the other foundations suggested for morality provides much in the way of a legitimate sense of security either. (Hull, 1989, pp.23-4)

There is an important distinction between the alternative commitments to consilience that are proposed by the accounts of Kant and Hull. Hull's implicit commitment to consilience is directed at deriving an explanation of morality from a naturalistic scientific principle such as one based on evolutionary contingencies.[73] In contrast, Kant's account of reason as determining, but not itself determinable, makes it possible for Kant to separate the practical and theoretical aspects of reason in a manner that does not result in the need to establish a single principle of consilience by which all human activity must be explainable. Kant's account of consilience is one that separates the different activities of humans (or finite rational beings) and explains how these activities can all be justified in accordance with the architectonic structure of transcendental idealism. It is a consilience at the level of *faculties* rather than *facts*. He emphasises that unity in nature is the product of ideas and not vice versa. This means that ideas are determined by nature in neither their theoretical nor practical applications. In relation to theoretical reason,

> One cannot properly say that this idea is the concept of an object, but only that of the thoroughgoing unity of these concepts, insofar as the idea serves the understanding as a rule. Such concepts of reason are not created by nature, rather we question nature according to these ideas (CPR A645/B673)

Reason in its theoretical use only determines appearances, not objects in themselves. It provides the understanding with a guideline by which it can search for ever increasing

[73] This is supportive of the commitments to consilience previously discussed in relation to Mackie and Wilson. They also suggested any account of morality must be compatible with biology. See Chapter Three (2.2).

unity in its determinate use, whilst simultaneously recognising that such unity will never be satisfactorily demonstrated for nature as a totality, rather, it must be presupposed. For Kant, this role of reason is not heuristic in the sense that it is merely a possible way that we can increase the scope of nature by appealing to an unconditioned principle. It is essential for the possibility of empirical enquiry; without reason we would have 'no coherent use of the understanding, and, lacking that, no sufficient mark of empirical truth' (CPR A651/B579).

This relates to the previous discussion of Breitenbach's and Choi's (2017) account of unified pluralism. They emphasised the epistemic virtue of the Kantian account is that it demonstrates the need for philosophers of science to approach nature as if it were unified in order to establish science as a communicative and collaborative process. Such a unity does not ever need to be ultimately discovered.[74] On my interpretation of Kant, such a unity could not be discovered in principle, as this would require the collapse of the 'gap' between the undetermined idea of unity and the determination of nature by the understanding in accordance with this unity. This unity could only ever be justified as a transcendental condition of enquiry for the possibility of conceiving of appearances in relation to an undetermined idea of systematicity, which itself could not be regarded as a systematicity relating to things in themselves. If this related to things in themselves, then it would result in the denial of the possibility of freedom.

Kant describes the structure of laws as 'all alike' insofar as they impose an intelligible structure. Hence Kant argues that this supports the primacy of practical reason insofar as 'natural law serves only as a *type* of a law of freedom' (CPrR 5:70). Moreover, Kant establishes a strong analogy between laws of nature and freedom in the *Groundwork*: '*act as if the maxim of your action were to become by your will a* **universal law of nature**' (G 4:421). In this sense, the capacity to deploy laws in the context of nature as regulative ideals which establish unity for scientific enquiry is not opposed to Kant's conception of morality. Instead, it offers support to morality insofar as the rational capacity to view experiences of nature in accordance with lawlike regularity is made possible by the same faculty that can establish universal maxims (i.e. categorical imperatives) that govern action.

[74] See Chapter Three (2.1)

The problem that Kant's account of morality raises for Dupré's conception of agency is that Dupré does not sufficiently account for the ability for humanity to set itself goals that can be achieved at the societal level. The activities that Dupré identifies are not necessarily examples of moral actions under Kant's account. The problem is that such activities could be motivated either by a sense of duty or for some other self-promoting interest. For instance, Kant considers how a shop keeper could decide not to raise the price of his products in virtue of his commitment to honesty and duty, while on the other hand the shop keeper could also perform this very same action to out-compete other shop keepers (cf. G 4:397). In this case, the shop keeper could be acting in accordance with their own self-interests toward increasing future financial security. On Dupré's account, it could be suggested that either of these motives for action are sufficient for his account of freedom, in both cases these actions originate from the subject and cannot be appropriately explained in terms of genetic reductivism. This is partially compatible with Kant's account to the extent that it is not directed at proving the existence of freedom. According to Wood, 'Kant does not pretend to know how free agency is possible, but claims only to show that the impossibility of freedom is forever indemonstrable' (Wood, 1984, p.99) However, if this is the case—that both self-interested actions and actions carried out in accordance with a Kantian sense of duty are sufficient expressions of freedom—then we must concede that actions motivated by self-interest do not always entail positive implications for society. Dupré's general focus is on societal changes that have been beneficial for human societies, such as readily available access to food, health-care, and education. In this sense, they are supportive of the idea that culture can be the source of major evolutionary change (Dupré, 2012, p.284). The problem that is not considered by Dupré, but is essential for Kant's political philosophy, is explaining how these developments that offer potential support for every member of a society *ought* to be established. Kant argues that for every individual to receive the benefits of health-care and education we must first presuppose a unified will of the people to develop a society that will perpetually maintain itself. In such a society it is the responsibility of the state to 'maintain those members of society who are unable to maintain themselves' (MM 6:326). Kant's suggests that the state ought to achieve this by imposing constraints on the wealthy individuals of society to provide basic support for those in need. The wealthy are obligated to fulfil this role for the state, 'since they owe their existence to an act of submitting to its protection and care, which they need in order to live' (ibid).

Dupré does not explicitly advocate that these forms of societal change ought to be universal. However he does argue that they are benefits that the majority of us receive. The similarity between Kant and Dupré is that both are advocating the importance of human activity in a way that cannot be accounted for under the conditions of biological determinism. Kant's account diverges from Dupré's insofar as it is concerned with how a society ought to develop in a way that preserves the freedoms of its citizens.[75] For Kant, investigating how a society ought to develop is made possible because the values that such a society are directed toward are the same as those values of his moral philosophy. According to Kant,

> By the well-being of a state is understood […] that condition in which its constitution conforms most fully to principles of right; it is that condition which reason, *by a categorical imperative*, makes it obligatory for us to strive after. (MM 6:318)

This difference between Kant and Dupré is further elucidated by appealing to Kant's distinction between moral anthropology and the metaphysics of morals. The former examines the subjective context that can either hinder or aid societies toward the fulfilment of laws that constitute a metaphysics of morals. In this sense, anthropology cannot be the source of a metaphysics of morals for society, although Kant suggests that a metaphysics of morals can be subsequently applied to anthropology (MM 6:217). A metaphysics of morals must be separated from anthropology because its laws cannot be derived from nature; rather it must be based on the moral sense of duty that every human possesses (MM 6:216). Kant's political philosophy demands the separation of nature and freedom that constitutes the division between theoretical and practical philosophy. In this context, Dupré's account might be considered as closer to an anthropological account as his account lacks the normative dimension that suggests not only that society does develop in a way that promotes the well-being of its citizens, but that it *ought* to be engaging in these practices.

On a related matter, Mackie's argument from queerness could be applied to Kant's political philosophy. Recall that Mackie argued against Kant's moral philosophy on the basis that something cannot be both prescriptive and objective.[76] Objective statements

[75] A related aspect of Kant's political philosophy was discussed in Chapter One (2.2). Kant's opposition to political revolutions was compared with Kuhn's conception of scientific revolutions. I argued Kant would have opposed Kuhn's appeal to political revolutions as support for scientific revolutions. For Kant, political revolutions are not compatible with the development of society in accordance with the reason.
[76] See Chapter Three (2.2)

about what is the case can only be established in relation to empirical natural facts. As these aspects of Kant's political philosophy are intended to be derived from the principles of Kant's moral philosophy, Mackie's argument could also be extended to Kant's political philosophy. Korsgaard summarises and rejects Mackie's argument against objective values as follows:

> Knowledge of them, Mackie said, would have to provide the knower with both a direction and a motive […] Of course there are entities that meet these criteria. It's true that they are queer sorts of entities, and that knowing them isn't like anything else. But that doesn't mean that they don't exist. (Korsgaard, 1996, p.166)

In the context of Kant's political philosophy, the intuitive appeal of Korsgaard's treatment of Mackie's argument is compelling. If the policies that societies establish are developed in accordance with the moral sense of duty, then they are both normative and objective. Dupré also considers the division between facts and values. He argues that values are evaluative claims that hold some interest for society, whereas facts possess little interest for society: 'if most or all of physics is value-free, it is not because physics is science, but because most of physics simply doesn't matter to us' (Dupré, 2012, p.58). Dupré does not intent to purge values from science, but rather to understand 'how normativity finds its way into scientific work, and how its denial can be potentially dangerous' (Dupré, 2012, p.59).

It is important to make explicit both the values that can motivate scientific research and the implicit values that can affect the methodology of research. For instance, Dupré considers how research into the evolution of rape has appealed to similar behaviours in nature exhibited by flies or ducks. He argues that the lack of biological similarities between these entities reveals how such connection is insufficient; 'only in the crudest analogical sense could […] the behaviour of copulating flies be related to that of human rapists' (Dupré, 2001, p.63). Appeals to this kind of argument have become less frequent in contemporary evolutionary theory, but the underlying point is that such examples emerge because research does not consider the relevant differences that dispose individuals to these behaviours in different species. For humans, rape is inherently a normative concept in both the way it is defined and the motivations for these actions. According to Dupré,

> Those who have thought seriously about contemporary sexual violence as opposed to hypothetical reproductive strategies of imagined ancestors have observed that rape […] has more to do with misogyny,

> and more to do with violence than sex, let alone reproduction. Its causes appear therefore to be at the level of ideology rather than economics.
> (Dupré, 2012, p.60)

Dupré aims to show both how values are inseparable from the study of science and reveal the importance of understanding the inherent normative dimension of scientific methodology. This means that science is not relegated merely to the domain of factual statements that do not matter for us. Dupré commends the sociobiological account because of its emphasis on the distinction between something being natural and it being good. In this sense, even if it were possible to provide a naturalistic explanation of rape, this would not entail that by extension rape is good. In contrast, it is good that research aimed at discovering the factors that dispose individuals toward these behaviours can, if successful, be used to inform policy to reduce these factors in the future. The problem is that these factors are difficult to identify, especially if such research does not consider the relevant normative contexts that dispose individuals toward these behaviours.

This account is largely consistent with Kant's political philosophy. The well-being of a society would require the state to be continually vigilant against the abuse of the rights of its citizens. It could be argued that the normative aspects of Dupré's account of biological freedom requires something similar to Kant's account of morality and political philosophy to support the development of science toward socially progressive research. The relation that Kant establishes between his moral and political philosophy allows Kant to explain why research *ought* to be directed toward influencing policies that increase the protection of the state against harm that all citizens benefit from. In the context of Kant's critical philosophy, this would require us to regard the objects of our scientific understanding as guided by the regulative ideas of theoretical reason, not as objects in themselves. This is necessary to account for how humans can develop maxims from an atemporal and non-natural standpoint. This is not because of the determinacy of nature, but rather because the reason why actions are deemed of moral worth is because they are generated by the capacity of humans to set themselves ends in accordance with duty at both the individual and societal levels.

2. Natural teleology and biological autonomy

This section considers how Kant's account of the organism has been appealed to in relation to accounts of biological autonomy in contemporary philosophy of biology. They

argue that Kant's conception of teleological judgment offers support for the notions of biological closure and Kantian wholes that are central for their accounts. In contrast, Kant's conception of teleological judgment must be understood in the context of transcendental idealism and specifically its relation to his conception of moral teleology. This focus on moral teleology reveals that Kant's primary concern is not directed toward explaining the emergence of natural entities that possess the capacity for self-organisation, but rather with our ability to *judge* nature as possessing these kinds of entities.

The role of moral teleology tends to be overlooked within contemporary interpretations of Kant's account of teleological judgment. I argue that these two kinds of teleology should be interpreted as analogical counterparts to the power of reason to view nature and freedom in accordance with ends. This is in opposition to interpretations of Kant that reject the strong relationship between Kant's accounts of moral and teleological purposiveness. I argue this supports the interpretation of Kant as offering an account of consilience at the level of faculties discussed in the previous section.

1. Biological autonomy in contemporary philosophy of biology

Kant's conception of the organism has been influential on various accounts of agency in contemporary philosophy of biology. For instance, Kauffman appeals to the conception of Kantian wholes as a way of understanding organisms as possessing their own agency and autonomy in their process of self-recreation. This makes it possible to understand how organisms essentially possess functions. According to Kauffman,

> It is this combination of self-recreation of a Kantian whole, and therefore, its very existence in the non-ergodic universe above the level of atoms that, I claim, fully legitimizes the word, "function" of a part of a whole in an organism. (Kauffman, 2013, p.5)

Kauffman deploys Kant's account of organisms in the Third *Critique* to explain how organisms must first possess the ability to act in such a way as to produce a function which can become a unit of selection. Organisms possess the features of self-reproduction and metabolism. Kauffman defines metabolism as a process in which the activity or work carries out a work cycle (Kauffman, 2000, p.68). Work cycles can explain how both organic and non-organic systems utilize energy from their environments to perform an activity that results in the final organisation of the relevant parts and whole of the entity

as ready for another cycle of work. Work cycles cannot occur at equilibrium; they require a differential arrangement of parts to make it possible for an entity to perform a function.

The difference between work cycles in organic and non-organic systems is that the former establish their own boundaries and causal closure, whereas for the latter these features are constructed externally. This difference is also central to the account of biological autonomy developed by Mossio and Moreno. They argue that the paradigm example of an entity that possesses biological autonomy is a genetically homogenous multicellular organism. The difference between these kinds of organisms and artefacts is that the former 'result from a process of *differentiation* between their functional parts, and not from the *aggregation* of pre-existing entities' (Moreno and Mossio, 2015, p.149). Importantly, this process of differentiation of functional parts is regarded as emerging internally from within the organism. They identify this as a development of the Kantian distinction between organisms and artefacts. According to Mossio and Moreno,

> organisms realise closure, while artefacts do not. Accordingly, while for the Darwinian tradition, the comparison between a watch and an organism – even regarding only contrivance and relation between parts – suggests an analogy, the organisational view requires an essential distinction.[77] (ibid)

Kauffman also appeals to Kant's account of the organism to describe how cells carry out constraint construction, and other construction projects (such as DNA replication) which establish a closure in which the cell can create a rough copy of itself. According to Kauffman, '*this whole process is precisely the self-propagating organization to which Kant pointed*' (Kauffman and Clayton, 2006, p.510). From this Kauffman argues that life can be understood as an ontologically emergent process which involves a reciprocal relationship between matter, energy, information, entropy, and more. For Kauffman, these Kantian wholes are a prerequisite for natural selection as natural selection can only act on entities that possess the capacity for self-propagating organisation.

Mossio and Moreno describe the causal cycle of constraints through the following thought experiment: imagine there are two balls on a table that is configured in such a way that when the second ball is hit by the first ball, the second ball comes back and hits the first ball starting the cycle over again. In ideal frictionless conditions, the constraints (table, boarders, balls) will entail that the initial application of a force will result in 'a

[77] The role of the analogy between artefacts and organisms for Darwin's theory was discussed in Chapter Four (2).

causal cycle of constrained processes' (Mossio and Moreno, 2010, p.278). In this situation, a causal cycle is established, but not organisational closure. This is because the constraints are not generated from within the system, but rather imposed externally. Biological closure requires that the entity has a level of internal complexity that allows it to take control of various environmental factors that contribute to the boundary conditions required for the maintenance of the system. Biological closure achieves a greater level of autonomy and independence from perturbations in environments. In contrast, non-biological self-organising systems (or dissipative structures) only contribute to their own maintenance in a single way and small variations in the environment can result in the loss of organisation for the whole structure. Biologically autonomous systems achieve biological closure because they possess a physical boundary that non-organic self-organising systems lack. According to Moreno and Mossio, 'self-organising systems are not delimited by a physical border, all biological cells possess a membrane […]. Membranes help distinguish the system from the environment, while at the same time enabling it to act on relevant factors' (Moreno and Mossio, 2015, p.17). This reveals the difference in kind between dissipative structures that possess a basic form of self-organisation and entities that possess biological closure. It is not possible to sufficiently understand autonomy by looking solely at 'self-organisation as it occurs in physics and chemistry' (Moreno and Mossio, 2015, p.18). Nicholson argues that this is an excessive conclusion because Mossio and Moreno agree that life must have originally emerged from non-living dissipative structures and both are ultimately grounded in thermodynamics. Hence, it is not possible to discount the importance of non-living dissipative structures in the development of autonomous biological systems (Nicholson, 2018, p.152).

One reason why Mossio and Moreno might insist on such a strong distinction between these kinds of entities is because of their strong Kantian leaning. They argue that when causal closure is established, the emergent entity possesses the irreducible capacity to self-determine as a whole (Moreno and Mossio, 2015, p.61). In contrast to Kant, they argue that this does not require that the whole has a distinctive causal power as the power could be produced by the network of interrelated causal parts (Moreno and Mossio, 2015, p.58).

2. The relationship between physical and moral teleology in Kant's philosophy

In the context of his discussion of teleological judgment, Kant argued that both theoretical and practical reason are required in order to teleologically judge an entity as having a natural purpose. A natural purpose draws from practical reason insofar as the parts and whole act reciprocally for the sake of one another. This is analogous to the means and ends of categorical imperatives. In contrast, for efficient causation the whole only exists for the sake of the parts; the whole can neither precede the parts nor be the purpose that the parts exist for. A natural purpose is subject to temporal conditions insofar as it is an object of experience. Hence, it is also subject to the determinations of efficient causation and therefore cannot be explained as being postulated outside of time in the same way that the entities of practical reason are (i.e., categorical imperatives). Kant did not think that teleological judgments could reveal any knowledge of freedom, rather he asserted that physical teleology needed to borrow from principles of moral teleology. According to Kant,

> **moral** teleology makes good the defect of **physical** teleology, and first establishes a **theology**; since the latter, if it is to proceed consistently rather than borrowing, unnoticed, from the former, could by itself alone establish nothing more than a **demonology**, which is not capable of any determinate concept. (CJ 5:444)

When physical teleology is taken in isolation from moral teleology it could lead us to regard the purposiveness of biological organisms as justification for the existence of God which would be a demonology. Instead, our ability to conceive of physical teleology is made possible by our capacity for practical reason: 'given the subjective constitution of our reason […] this final end can be nothing other than **the human being under moral laws,** while by contrast the ends of nature in the physical order cannot be cognized *a priori* at all' (CJ 5:445). This is in opposition to Ginsborg's claim that the ability to view an organism as designed is not associated with the imperatives of practical reason. For Ginsborg, the difference between the practical and physical conceptions of teleology is that the former ascribes a value as a maxim such as a categorical imperative which is deemed to be good or rationally desirable. In contrast, judgments pertaining to physical teleology are not developed in accordance with a maxim and therefore cannot be regarded as rationally desirable or good in the sense of moral teleology (Ginsborg, 2015, p.252). In the absence of rational justification for teleological judgments of organic entities, Ginsborg argues that the entities judged teleologically display their own conditions for their primitive normativity. This means that when we perceive an organism such as a

horseshoe crab and judge that it ought to have eight legs, then 'our judging that they are as they ought to be is a condition of our judging that horseshoe crabs ought to have eight legs in the first place' (Ginsborg, 2015, p.244). The difference between organic and non-organic entities is that the latter cannot be judged in accordance with normative constraints. For instance, there is no way that a stone ought to be. Importantly, this is not a moral sense of ought; horseshoe crabs that have less legs, or eyes that lack the capacity for vision, are defective in the sense that they do not meet the criterion for their primitive normativity, but they are not morally defective.

Ginsborg is correct to separate the physical and moral notions of teleology in the sense that the former cannot be considered as morally defective. Kant distinguished these two aspects; 'such dissimilar principles as nature and freedom can only yield two different kinds of proof' (CJ 5:479). However, there is an alternative way in which moral and physical teleology offer support to one another. This support does not entail that they are both directed at the same proof, but rather the ability to conceive of both nature and practical reason in accordance with ends supports the human propensity toward this power of reason. In other words, physical teleology is supported by moral teleology because it is an analogical case in which nature can be considered in accordance with final causes. Moreover, when physical and moral teleology are taken in combination, this reveals that nature cannot be considered as the source of this capacity as it can only be grounded *a priori* in our capacity for moral reasoning.

Kant's argument that we conceive of natural purposes by analogy with our own rational capacities has been subject to dispute. For instance, our ability to conceive of organisms in accordance with our own rational capacities has been interpreted by Breitenbach as extending beyond our 'ability for free and end-directed activity, […] presenting a complex capacity whose different functions are purposively related to realizing and maintaining the capacity of reason as a whole' (Breitenbach, 2014, p.136 fn.7). *Pace* Breitenbach and Ginsborg, I argue that the analogy with our own rational capacities should be understood as relating specifically to the relationship between moral and physical teleology. This is textually supported by the concluding section of the Third *Critique* which offers a comparison of the relationship between moral teleology and the physico-theological proof of God's existence.

The physico-theological proof suggests that God's existence can be derived from the intentional design of nature. Kant argues that the physico-theological proof cannot sufficiently justify God's existence because this would require us to conceive of the intelligence of this original being (CJ 5:480). This is impossible because it would demand the transcendence of our own intelligence to view an intelligence greater than ourselves. Instead of proving the existence of God, moral teleology supplements the shortcomings of physical teleology because it 'rests on *a priori* principles that are inseparable for our reason' (CJ 5:481). Moral teleology offers support for physical teleology, but the latter does not offer substantive support for the former. According to Kant, '[t]he moral proof […] would thus always remain in force even if we found in the world no material for physical teleology at all' (CJ 5:478).

The emphasis of Kant's argument is that the capacity to view nature teleologically is grounded in our capacity for practical reason and morality. Natural teleology merely offers corroboration—but not proof—for moral teleology. Moral teleology is already grounded on *a priori* principles that are inseparable from reason. Importantly, physical teleology cannot offer confirmation for the conclusion of the moral proof which is directed toward demonstrating that God is indispensable for practical reason. Rather it supports moral teleology because nature is 'capable of displaying something analogous to the (moral) ideas of reason' (CJ 5:479).

This analogy is based on the similarity in structure between physical and moral teleology. This reinforces the idea that Kant's critical philosophy can be regarded as advocating consilience at the level of *faculties*, rather than *facts*, which was discussed in the previous section. Physical teleology only offers additional support to moral teleology insofar as it reveals an analogous manifestation of our ability to judge in accordance with ends. This offers support to the account of Kant as offering an account of consilience at the level of faculties because whilst natural teleology cannot offer support to the argument for the existence of a supreme being, the analogical relation between physical and moral teleology offers corroboration for the moral proof.

In summary, there are significant differences between Kant's account of the relationship between physical and moral teleology and the conception of Kantian wholes appealed to by advocates of biological autonomy. Kant's argument suggests that the ability to view nature teleologically is derived from our ability to formulate moral

maxims. Moral teleology does not require that nature displays teleology, but the fact that it does offers additional corroboration for our capacity for moral reasoning. We can infer from this that it would not be possible to conceive of nature teleologically if we did not have the capacity for moral teleology. The contemporary account of biological autonomy borrows from Kant's account of physical teleology to explain organisms as biologically autonomous wholes which are responsible for their own self-organisation. Kant's critical philosophy does not offer sufficient justification for the conclusion that nature contains entities that possess the capacity for self-organisation, what Kauffman terms "Kantian wholes". For Kant, our ability to perceive such entities is dependent on our moral reason, but this still only relates to our ability to *judge* nature as possessing such entities rather than revealing that such entities persist independent of experience.

3. Kant's influence on immunology

This final section examines how the influence of Kant's account of the transcendental unity of apperception was influential for the development of immunology. By examining the history of the self-metaphor and its philosophical legacy it will be shown that immune identity has its roots in a non-physical conception of identity. By understanding the philosophical motivations behind the self-metaphor, we shall explain how the self-metaphor offered a solution to the problem of agency and identity for immunologists. However, this solution is problematic because it was based on a misunderstanding of Kant's account of self-knowledge. This will show that historically immunology has depended on principles that are incompatible with naturalism. Recent theories of immunity such as Pradeu's continuity theory develops an alternative conception of immunity that does not depend on the conception of immune selfhood. The immune system tolerates and polices various endogenous and exogenous biological entities that comprise the organism. The concept of the organism that arises from the continuity theory is a continuation of the physiological account of biological individuality that has been understood as originating from Kant's account of the organism.

1. The role of the self-metaphor in the development of immunology

Until recently, the science of immunology has developed on the basis of the notion that the self is intrinsically related to the immune system. Contemporary immunologists insist

the self ought to only be considered metaphorically, as a heuristic principle that has guided immunology when the limit of attainable scientific precision has lagged behind its conceptual counterpart. Tauber appeals to the creativity of applying such metaphors in science since 'metaphors may be found to stimulate fecund scientific models' (Tauber, 1994, p.199-200). In contrast, Pradeu argues the self has become an unnecessary vestige of an outdated approach to immunology; 'the self has only been maintained until today because no immunologist has tried to define it more exactly' (Pradeu, 2012, p.129). The original application of the self-metaphor within immunology developed from the scientific and philosophical context of the 19th century. Tauber explains how the conception of the self was 'borrowed from philosophical discourse to denote concerns about the source of immune activity, that is, the identity problem' (Tauber, 1994, p.141).

According to Tauber, the conception of immunology first proposed by Metchnikoff was originally influenced by Kant's conception of the self. Metchnikoff was a Russian embryologist who developed the phagocytosis theory of host defence. He argued that the primary function of the immune system was not to protect the host, but rather to establish an ontological organismic identity. Hence, '[t]he immune system is fully activated, proceeding with its endogenous business, irrespective of the environment' (Tauber, 1991, p.16). The self-referential nature of Metchnikoff's account of the immune system entails that the protection it offers is merely a consequence of establishing its own identity.

Subsequent immunological theories such as Erhlich's 'horror autotoxicus'[78] established at the beginning of the twentieth century focused on this aspect of immunological self-recognition. Erhlich argued it was 'inconceivable than an organism could attack itself […] to the point of destruction. The organism must therefore be capable of distinguishing what belongs to it and what is foreign to it' (Pradeu, 2012, p.52). It followed that the immune system must possess the capacity for self-knowledge: 'since the immune system can recognize self constituents, it should possess the "know thyself"' (Avrameas, 1991, p.154). This idea of possessing the ability to know thyself is a reference to the Dephic motto 'gnothi seauton'. The connotations invoked by this connection reveal how the original development of the immune self was not scientifically robust. According to Tauber, '*"Gnothi se auton"* goes well beyond invoking an allusion to the mind or

[78] Meaning the horror of self-toxicity.

embodiment; it evokes a Western psychological conception of a bounded, autonomous, "discoverable" subject' (Tauber, 1994, p.185).

This account of the strict distinction between self and non-self was brought into question by Burnet and Fenner who discovered that when a foreign body was introduced to an organism in its developmental stages it did not produce an immune response. They argued that the immune system acquired an identity over time; those components that are present in the developmental stages are tolerated by the immune system. Thus, the immune system gradually distinguishes those components that are familiar and those that are alien to itself. This results in a more 'concrete' immunological self; the self is acquired through a process of 'hardening'.

In contrast, according to the continuity theory of immunology the organism is no longer distinguishable from its microbes. In virtue of an increased understanding of immunological mechanisms 'the notion of a permanent core of the organism's identity becomes unnecessary' (Pradeu, 2012, p.249). In support of this general way of conceiving the body, Dupré and O' Malley have argued we ought to describe ourselves as 'macrobes' in order to emphasise the underlying microbial processes that constitute the body. According to Pradeu, 'endobacteria (i.e., the symbiotic bacteria that live in the organism) are not simply "present" in the organism, they are *part* of this organism' (Pradeu, 2012, p.247). This supports the idea that the organism can no longer be defined in terms of genetic homogeneity; rather the identity of the organism is instead related to immune surveillance or policing mechanisms. These mechanisms respond to irregularities in molecular patterns regardless of their origin. The immune system responds to these irregularities 'be they endogenous (as in the case of tumor cells, which are genetically self cells but which do trigger immune responses) or exogenous (as in the case of pathogenic bacteria, parasites, viruses, etc.)' (Pradeu, 2013, p.89). In this sense the identity of the organism is processual, it never hardens but is re-establishing itself at every moment.

This brief historical outline has considered how the relation between self and immune identity has altered during the development of immunology. According to Pradeu's continuity theory, anything that is tolerated by the immune system is part of the identity of the organism. This is very different from Metchnikoff and Ehrlich's theories

that argue that immune identity requires the ability to distinguish between self and non-self components.

2. Kant's influence on immunology

According to Tauber, the development of the immunological self-metaphor is indebted to Kant's philosophy. Tauber describes Kant 'as the consummate architect of the modern self as an autonomous and self-determining subject' (Tauber, 1994, p.290). Thus, Tauber identifies Kant as the most likely inspiration for immunology.[79] Importantly, Tauber's account of Kant's influence on immunology misinterprets Kant's conception of the self. Tauber equivocates between two methods by which Kant derives the self. This equivocation is between Kant's transcendental unity of apperception (TUA) on the one side, and his account of the teleological judgment of organisms on the other. The TUA refers to the '**I think**, […] which in all consciousness is one and the same' (CPR B132). Kant argues that the TUA is a necessary condition of experience, for without it we would not be able to identify disparate experiences as belonging to the same consciousness. Although the TUA is a necessary condition of experience, this does not allow us to infer that we have access to knowledge regarding this self. Kant emphasises that the 'consciousness of the self is very far from being a knowledge of the self' (CPR B158).[80] The TUA is neither constituted from experiences nor is it an entity; it is a precondition for experience as such.[81]

Tauber interprets Kant as suggesting that we have knowledge of the self as the TUA. To this effect he emphasises that for Kant 'the self was capable of knowing itself only because it could also know the world as an object' (Tauber, 1994, p.236). According to Tauber's interpretation of Kant, our knowledge of the TUA is related to the immediacy

[79] Although Tauber identifies Kant as a possible source of inspiration for immunology, his *The Immune Self* does not solely focus on Kant. Tauber continues to explain how the self-metaphor has developed through philosophers such as Schopenhauer, Nietzsche and Foucault. Tauber ultimately argues the immune-self is processual. This chapter-section, however, will only focus on Tauber's discussion of Kant.

[80] This is from Smith's translation as the term '*Erkenntnis*' is translated as knowledge, whereas Guyer and Wood translate this as cognition.

[81] Kant explains that it is his conception of the self as the aspect of his philosophy that creates the strangest impression: "But in the theory of all objects of sense as mere appearances, there is nothing that creates a stranger impression than that I […] can be known to myself as appearance merely, not according to that which I am as thing-in-itself" (PM 20:269)

of our body. This, as well as our faculty for practical reason, justifies knowledge of ourselves as the TUA. According to Tauber,

> the world is phenomenal and therefore fully objective, real and discernible to a knowing subject, because everything beyond phenomenality is an empty phantasm. However, for one case Kant allows immediacy of knowledge, namely, that of knowledge of ourselves. Such knowledge is uniquely practical and is available in the immediacy of our bodies and as an exercise of our autonomy.
>
> (Tauber, 1994, p.239)

In other words, Kant argues that the only thing known to exist beyond experience is the self; everything else is an empty phantasm. However, Tauber's justification for this interpretation rests on the self as conceived as embodied, practical and autonomous. The amalgamation of these different senses of the self results in a concept of the self that is autonomous, self-aware, self-determining and physically instantiated. However, this is fallacious as the TUA is merely a necessary condition for experience and is not identical with embodiment. It is the condition of the unity of experience, but this does not necessarily relate to the physical embodiment of the self.

The TUA only relates to the necessary condition for the consciousness of our own self-identity. In contrast, Kant argues that when we judge an entity as an organism we cannot directly perceive the self-organising features that the organism is judged to possess. Instead we can only know that we must judge the organism *as if* it possesses these features, but this can only be known as a condition of teleological judgment. We cannot know if these judgments are identifying features of the entity or features of judgment itself. In judging an entity as having a natural purpose, then, the judgment must be considered as referring to 'something that is not empirically cognizable nature (supersensible) and thus is not cognizable at all for us' (CJ 5:396). Therefore, judgments pertaining to organisms do not result in knowledge of organisms.

In this sense, Kant did not regard the TUA and teleological judgments of the organism to be referring to a unified self. The TUA is a necessary condition of experience whereas the grounds of teleological judgments of the organism remain beyond the remit of experience. If Tauber is correct, then immunology has not appreciated this difference. He argues that the realisation of the contingency of the self has moved immunology away from the Kantian conception of the self. Thus, he states:

> If, however, the self is a contingency, there is no unity by which the self may be organized to confront its world. The postmodern view of the

> self disallows Kant's modern subject to determine for itself, completely and unconditionally, what to accept as evidence about the nature of its world or its organization […] What is at stake is not only *what* the self is, but whether a self even *exists.* (Tauber, 1994, p.281)

Tauber considers the contingency of the self to be what *disallows* the application of the Kantian self. On the contrary, to acknowledge the contingency of the self is finally to adopt a Kantian conception of the self. In terms of the TUA, the self cannot be known to exist but it must be presupposed in order to account for our experiences as belonging to the same subject. In terms of our teleological judgments, we can only judge organisms *as if* they possess the capacity for self-organisation within themselves. The physical embodiment of the self is contingently dependent on teleological judgment. This is central to the distinction between the TUA as a necessary condition for experience (something which we cannot have knowledge of) and the teleological judgment of the self as the embodied organism (which is only known in a limited and contingent sense). Ironically, the immunological account of the self more accurately corresponds to the Kantian self at the point it denies any such relation is possible.

3. Beyond the self-metaphor: The continuity theory

Contemporary immunological theories such as Pradeu's continuity theory assert that it is now possible for immunology to proceed without utilising the self-metaphor. According to Pradeu, 'immune interactions isolate some continuous biochemical interactions, which in turn individuate the organism: the notion of a permanent core of the organism's identity becomes unnecessary' (Pradeu, 2012, p.249). Hence, the problematic relation between what does and does not constitute the self is resolved by identifying the boundaries of the organism with mechanistic biochemical responses. The organism can be composed of many different exogenous parts: it is 'from its very birth open to its environment, which allows it to integrate indispensable symbiotic microorganisms' (Pradeu. 2012, p.155). What makes it possible to identify something as an organism is that the different components of a biological individual are 'cohesively organized through an immune system' (Pradeu, 2013, p.89). The immune system is a policing mechanism that monitors the diverse endogenous and exogenous components that constitute the organism. Importantly, the cause of an immune response is not necessarily exposure to genetically foreign entities, rather it responds to strong deviations in molecular patterns. The continuity theory rejects the conception of the organism as requiring an immune self.

> The self-nonself theory thinks of the organism as largely closed to its environment […]. The continuity theory, in contrast, considers the organism as first and foremost tolerant to its environment (i.e., that it needs to be tolerant in order to develop and survive)
>
> (Pradeu, 2012, p.148)

Pradeu separates biological individuals into two distinct kinds: evolutionary and physiological individuals. Physiological individuals possess an immune system and include all biological entities that are tolerated by that immune system. According to Pradeu, 'the physiological individual, immunologically, is the unit made of the association of a host and many microbes' (Pradeu, 2016, p.805). In contrast, evolutionary individuals are entities that are the product of natural selection. These individuals can be below the level of physiological individuals (such as genes and chromosomes), physiological individuals themselves, or above the level of physiological individuals (such as populations).[82] The difference is that physiological individuals can form associations with different biological entities that are not the product of evolutionary lineages such as they can acquiring microbiota from their environments. Crucially, the conception of physiological individuals proposed by the continuity theory does not distinguish between associations which are parasitic or symbiotic. Any entity tolerated by the immune system is part of the physiological individual.

For instance, recent research into treatments for *clostridium difficile (c.diff*) have indicated that faecal microbiota transplantations (FMT) is a very effective treatment (Van Nood et al. 2013). This treatment consists of taking stool from a healthy donor and transplanting it into the gut of an individual suffering from *c.diff.* This re-establishes the normal functionality of the microflora that is disrupted by the *c.diff.* infection. They found that FMT successfully cured 94% of cases in contrast to the traditional gene therapy that only successfully cured 27% of cases. In the context of the distinction between evolutionary and physiological conceptions of biological individuals, this shows how the physiological individual can acquire new microbiota from their environments that re-establish normal functionality. The microbiota from the healthy donor becomes part of the physiological identity of the recipient. Importantly, this is not because of the benefit of FMT for individuals with *c.diff* infections, rather it is considered as part of their physiological identity because it does not produce an immune response.

[82] Evolutionary individuals are also referred to as Darwinian individuals in accordance with the account presented in Godfrey-Smith, P. (2009) *Darwinian Populations and Natural Selection*. Oxford: Oxford University Press.

Whilst microbiota and other biological entities acquired from environments which are tolerated by the immune system might be beneficial for the host, these benefits will not always be explainable in terms of evolutionary processes. To be considered as an evolutionary process, the associated microbiota must be transmitted from parent to offspring 'vertically' as a lineage, whereas microbiota can also be acquired from environments 'horizontally'. According to Pradeu,

> In the case of vertical transmission, physiological individuals understood as host–microbe associations can be highly realised Darwinian individuals, because lineages of these associations can be established. But in the case of horizontal transmission, physiological individuals understood as host–microbe associations do not constitute lineages as associations. Rather, those associations are local concentrations of different lineages. (Pradeu, 2016, p.810)

Research has revealed that 'helminth[83] infections exerted a strong selective pressure on our genome' (Weinstock and Elliot, 2014). According to this research, '[d]ecreasing rates of contracting helminthic parasites has contributed to cases of inflammatory bowel disease, type 1 diabetes, multiple sclerosis, and other conditions' (ibid.). This host-parasite association is not an evolutionary or Darwinian individual as the association is not vertically transmitted from parent to offspring. In addition, this association can be detrimental to the host. However, evolutionary pressures have been exerted on this host-parasite association as the decrease in parasitic infections has contributed to the rise in several medical conditions. The continuity theory would argue that if the helminths are tolerated by the immune system, then they are part of the organism regardless of the benefit or detriment to the host's fitness. The idea that there is a clear distinction between parasitic and symbiotic relations presupposes this relation is reducible to a single function that is either 'good' or 'bad' for the host. Hull explains that this is not typically the case in biology more generally; he states 'like it or not, a single structure can perform more than one function. […] In evolution, organisms must make do with what they've got. An organ evolved to perform one function might be commandeered to perform another' (Hull, 1989, p.21). If an organ within an organism can develop exaptive functions, that is functions it did not primarily evolve to perform, then it is not surprising that similar exaptive functions can be established between biological entities which form associations emerging from distinct evolutionary lineages. Combes explains that 'the passage from

[83] Helminths are parasitic worms that usually reside in the intestine.

parasitism to mutualism may result in rapid selective processes if innovative genes are available in the parasite genome' (Combes, 2001, p.556).

Kant's claim that judgments of organisms are not able to be reduced to mechanistic explanations provides an interesting perspective on these developments in immunology. By replacing the self-metaphor with the notion of immunological policing mechanisms that individuate organisms, the problem of organismic identity takes a different form. The continuity theory argues that the organism is a product of the biochemical mechanisms that constitute the immune system. Pradeu identifies Kant as responsible for the original explanation of physiological individuality as 'a coherent, functionally integrated whole, undergoing continuous change and made of causally interconnected elements' (Pradeu, 2010, p.252). Pradeu is receptive to Kant's conception of physiological individuality, but he argues that Kant's explanation is too closely aligned to the phenomenal conception of organisms. Kant's account of teleological judgment identifies the general conditions that an experience must fulfil to be judged as an organism, hence it is directed toward justifying the common-sense or phenomenal account of the organism.[84] The difference is the continuity theory suggests the organism is a functionally integrated whole that is comprised of heterogeneous components which are regulated by immune interactions (Pradeu, 2012, p.244). The continuity theory extends notions of physiological identity beyond the phenomenal account of the organism. It does not offer a definition of the organism, but rather it is '*a criterion of individuation*' (Pradeu, 2012, p.227). Organisms are uniquely individuated because each possesses a distinct immune system, the immune system 'is a subsystem of the organism' (Pradeu, 2012, p.240). The reason why the conception of the organism developed by the continuity theory is not compatible with the common-sense conception is that the organism includes both endogenous and exogenous entities; it is not genetically homogenous. This reveals a compatibility with Kant's account of teleological judgment as genetic homogeneity is not necessary for the ability to judge an entity teleologically. As previously explained, the virtue of Kant's conception of teleological judgment is that it does not rule out the entities that can be understood in accordance with teleological judgment in advance.[85] Both Pradeu and Kant agree insofar as organisms are systematic

[84] This is important because the common-sense account of the organism has been criticised for its biases toward our size and duration and perceptual abilities (cf. Hull, 1992, p.182)

[85] This was discussed in the previous chapter in relation to Kauffman's claim that storm-systems could be regarded as living entities. See Chapter Four (3.2)

unities or wholes, organisms must be both self-organised and self-organising (CJ 5:373-4). According to Pradeu, 'immunogenicity tells us than an organism is first of all a unified whole (its unity is founded on biochemical interactions, and above all on immune interactions), and second, that it is heterogeneous' (Pradeu, 2012, p.248).

The difference between their accounts emerges in relation to the ground of understanding the organism as a systematic whole. For Pradeu, this is a product of immune interactions, whereas for Kant this is established in relation to a 'supersensible determining ground' (CJ 5:377). From the perspective of transcendental idealism, the problem with Pradeu's account is that the immune system is both a subsystem of the organism that acts at the level of the whole to regulate the organism, but it is also constituted by particular mechanical biochemical interactions. In this sense, it requires that conceptions of efficient and final causality are both satisfied; that 'the connection of **efficient causes** could at the same time be judged as an **effect through final** causes' (CJ 5:373). For Kant, no such unification is possible and hence the capacity for teleological judgment is grounded in the supersensible. The parts and whole cannot both be causally efficacious at the same time. If the physiological individual as a systemic whole has properties which cannot be explained in terms of the particular biochemical immune responses that constitute it, then both the immune system and the organism are not reducible to particular biochemical mechanisms. Teufel explains how the idea of reciprocal causality between wholes and parts results from a confusion of two incompatible perspectives on material reality. The whole is either a nominal abstraction that is nothing more than the mechanisms that comprise it, or the whole endures independently from the parts which constitute it. According to Teufel,

> Either one considers a whole *qua* whole as composed by a unique set of token material parts—and then this whole cannot precede any of those parts—or one considers the whole more loosely qua enduring substance and thus with criteria of identity independent of its compositional relations […] to its parts (Teufel, 2010, p. 258)

In both cases, the whole cannot be causally efficacious on its parts. For the first case, the whole cannot cause its parts because it cannot precede them. For the second case, the whole cannot cause the parts because the whole has already been identified as persisting independently from its parts. Teufel explains that if the whole is not compositionally related to its parts then we cannot 'turn around and consistently claim that this whole, considered independently of its causal relation with its parts, *causes* its parts' (ibid). It is

unclear how Pradeu would respond to this charge as neither the immune system nor the organism is causally independent from its parts, but they are also not completely compositionally related to their parts either. At different times the immune system is comprised of different biochemical responses and the organism is constituted by different endogenous and exogenous entities. In this sense, both organisms and their immune systems are identified on the basis that they are continuously changing, yet their identities persist as systemic unified wholes. The particular biochemical immune responses of an organism at any point in time will not provide a sufficient definition of the organism or its immune system. This could be why Pradeu denies that the immune system provides a definition of organisms, rather the continuity theory offers a criterion for individuating physiological entities in terms of possessing an immune system. This does not entail that it would be possible to consider the organism as persisting independently from its immune system. Pradeu notes that if an organism completely lacked an immune system then it would die immediately (Pradeu, 2012, p.246).

Pradeu's account of physiological individuality could be supported by Kant's account of teleological judgment. This would resolve how such entities can be viewed as systemic wholes persists through time and are not identical with their manifestation at any moment. It would also be possible to explain how particular biochemical responses can be understood as forming a systematic whole. According to Kant, to judge an entity as a natural end requires us to judge that 'its parts be combined into a whole by being reciprocally the cause and effect of their form' (CJ 5:373). The problem is that this would require Pradeu to accept that the ability to identify an organism and its immune system is a product of judging nature *as if* it contained natural ends. The similarity between the accounts of Pradeu and Kant is not surprising as Pradeu identifies Kant as responsible for the emergence of physiological individuality. In this sense, Pradeu accepted many of the features of organisms that were identified by Kant's account of teleological judgment such as the capacity for self-organisation. Pradeu differs from Kant by relocating these conditions from the capacity of teleological judgment—which is limited to the common-sense or phenomenal account of the organism—to any entity that is regulated by biochemical immune responses. It follows that the continuity theory expands the scope of physiological individuals. This does not resolve the problem that the ability to view nature as containing systematic wholes (or natural purposes) requires the capacity to judge nature in accordance with teleological judgment.

In summary, Kant's influence has been crucial for the development of immunology as it appealed to his conceptions of the self as embodied and possessing self-knowledge. This significantly misunderstood Kant's philosophy as it equivocated between two senses of self in Kant's philosophy: the self as the TUA and the self as the product of teleological judgment. Moreover, these aspects of Kant's philosophy did not offer support for the immunological conception of the self. Kant denied that the TUA resulted in knowledge of the self and his account of the embodied organism only related to the regulative conditions of teleological judgment. In opposition to the immune self, Pradeu's continuity theory suggests that the organism is comprised of endogenous and exogenous entities that live both in and on the body which are tolerated and policed by biochemical immune mechanisms. Pradeu distinguished between the physiological and evolutionary accounts of biological individuals to reveal how physiological immune identity cannot be explained in terms of evolutionary processes. Organisms can form associations with entities that have distinct evolutionary lineages. If these associations are tolerated by the organism's immune system, then they become part of this organism. Pradeu identified the original explanation of physiological identity as originating from Kant's account of teleological judgment. He endorsed some of the principles of physiological individuality identified by Kant such as their capacity for self-organisation. The features that Kant identified were justified as a condition of the judgment of organisms, rather than relating to properties of organisms independent of experience. This exposed an inherent problem for the continuity theory as immune identity is causal both at the level of the parts of the organism and at the level of the whole. Kant's conception of teleological judgment could help resolve the incompatibility between these two kinds of causality by showing that the ability to judge organisms and their immune systems as forming wholes can only be understood in relation to judgment.

Conclusion

This chapter has examined three biological theories that have appealed to different aspects of Kant's critical philosophy to support their accounts. The theories were critically examined to assess their compatibility with transcendental idealism. Moreover, I explored how broader aspects of Kant's critical philosophy might offer additional support for these theories.

First, I examined Dupré's appeal to Kant's account of freedom in support of his conception of biological freedom. Dupré argued that Kant's account was along the right lines because he showed that the organism was the source of its own agency. It would be misleading to suggest that Kant influenced Dupré's account; rather there is a similarity between their accounts insofar as both view the organism as the source of its own agency. Dupré rejected the dichotomy that Kant established between freedom and determinism because he regarded Kant's account of freedom as developing in response to a deterministic conception of nature. Kant's account of nature in the Second Analogy is deterministic, but the compatibilism between nature and freedom is that both scientific laws and laws of freedom are regulative rational projections. In this sense, Kant regarded the ability to establish laws that related to nature and freedom as two alternative ways that laws can guide enquiry. For both cases, the object in itself cannot be determined, so such laws are merely regulative principles.

Both Kant and Dupré are concerned with how societal level developments should be understood as emerging from human agency. For Dupré, biological accounts that focus on genetic reductivism will not be able to explain how societal developments can be sources of evolutionary change. He considers access to healthcare and education as examples of this. I argued that Dupré's account implicitly focused on societal developments that could be understood in accordance with Kant's account of political philosophy. He argued that science must recognise the impact of values on scientific enquiry. For instance, he suggested it is good that science develops in a way that promotes social progression and discourages citizens from engaging in behaviours that are detrimental for its citizens such as rape. This is supported by Kant's political philosophy which argues that it is the responsibility of the state to ensure a level of protection for its citizens and support those members of society that cannot support themselves. The principles of Kant's political philosophy are motivated by his moral philosophy. The difference between the accounts of Dupré and Kant is that the former is arguing that societal developments have resulted in major evolutionary change, whereas Kant's political philosophy offers the foundations for the view that society *ought* to develop in these ways. If philosophers of science desire a theory that not merely recognises that values are inherently related to scientific research, but also aims to direct scientific research toward the promotion of socially progressive values, then Kant's political philosophy offers one way of showing how this can be achieved.

The second section examined contemporary accounts of biological autonomy that appeal to Kant's conception of physical teleology. The fundamental difference between Kant's account of teleological judgment and contemporary accounts of biological autonomy is that Kant regarded physical teleology as dependent on our capacity for moral teleology, whereas the contemporary account of biological autonomy does not consider moral teleology as important for the ability to conceive of nature teleologically. In the context of Kant's critical philosophy, the capacity to view nature in accordance with physical teleology is dependent on our capacity for moral teleology. This was contrasted with alternative interpretations of Kant's account of physical teleology which argue that there is no direct relation to his conception of moral teleology. For Kant, that nature can be conceived of teleologically does not offer additional support to the conclusions of the moral proof. However, it offers corroboration for moral teleology. Natural teleology displays an analogous case to moral teleology. This offered support the interpretation of Kant as developing a conception of consilience at the level of faculties, rather than facts.

The third section examined Kant's influence on the development of immunology. The notion of immune identity as an embodied self that possessed self-knowledge was influenced by Kant's conceptions of the self. I argued that this misunderstood and fallaciously equivocated between two accounts of the self in Kant's philosophy. The claim that the immune self possessed self-knowledge was derived from Kant's account of the transcendental unity of apperception. Importantly, Kant argued that this conception of the self only justified the awareness—but not knowledge—of the self. The conception of the self as embodied was derived from Kant's account of teleological judgment. This is also misleading as this only pertained to the conditions required for judging entities as organisms; it did not offer knowledge of the self as embodied. Following this, I considered how the continuity theory has rejected the conception of the immunological self. The continuity theory regards the organism as open to its environment and integrated with indispensable symbiotic associations it establishes with microorganisms. Recent research into *c. diff* infections found that stool transplantation from a healthy donor was the most effective treatment for curing these infections. This offers strong support to the continuity theory as it demonstrates how introducing healthy microbiota into an individual suffering from a *c. diff* infection can re-establish normal functionality. The continuity theory suggests that if this healthy microbiota does not produce an immune response, then it becomes part of the physiological identity of that organism.

Finally, I compared Kant's account of teleological judgment with the continuity theory. Pradeu identifies the explanation of physiological individuality as originating from Kant's conception of the organism. For both the organism is a systematic self-organising whole. The difference is that Pradeu relocates these features in the immune system rather than suggesting they are grounded supersensibly. I argued this requires that the immune system is understood simultaneously at the level of the whole which regulates the organism, and at the level of parts as a collection of particular biochemical responses. I argued that these types of causality are in tension with one another from the perspective of transcendental idealism. It requires that the immune system and the organism are understood in terms of both efficient and final causation. This tension could be resolved if Pradeu conceded that the immune system and the organism are dependent on judgment. This would show that the continuity theory extends the scope of the entities that can be understood in accordance with teleological judgment, but it does not refute the need to understand these entities as dependent on teleological judgment.

Conclusion

This thesis has surveyed various ways in which Kant's philosophy has influenced both the development of biology and contemporary philosophers of biology. In contrast to many discussions of Kant's philosophy that focus primarily on the Third *Critique* for understanding Kant's influence on biology, various elements of Kant's critical philosophy that stimulated developments for scientific theories have been examined. The conception of influence that has been developed throughout this thesis strongly advocates that the source of an influence must be distinguished from its warrant. This allows us to appreciate Kant's influence on the development of biology without presupposing that the source of this influence is compatible with its subsequent effects.

This incompatibility was first discussed in relation to Lenoir's account of Kant's influence on the development of the teleomechanist research program in 19th century German biology. Lenoir's account appealed to Lakatos' conception of research programs to explain how Kant constituted the hardcore principle or negative heuristic of that research program. According to Lenoir, this required those who identified themselves as members of the teleomechanist research program to assent to these fundamental Kantian principles. The main criticism raised against Lenoir's account of teleomechanism was that Kant's conception of the organism as a product of regulative judgment was not compatible with its subsequent biological deployment which regarded the capacity for self-organisation as a constitutive feature of organisms. Richards argued that 'Blumenbach clearly spied the Creator unabashedly pulling the strings, a perception no scientific theory in the Kantian mold would legitimate' (Richards, 2002, p.229). For Blumenbach, the self-organisation of organic entities allowed us to directly perceive the actions of the Creator, whereas for Kant our experience of entities as possessing the capacity for self-organisation was merely a mirror that revealed the conditions of our own capacity to judge these entities. This led Richards to conclude that Kant could not have been influential on the development of 19th Century German biology. In support of this conclusion, Zammito argued biology was founded on the principles of naturalism and Kant cannot be understood in accordance with naturalism: hence, '[o]nly by misunderstanding Kant did biology as a special science emerge at the close of the eighteenth century' (Zammito, 2006, p.765). *Pace* Zammito, I argued this offered support to Kant's influence on biology because it essentially emerged from *misunderstanding* Kant's philosophy. It would be contradictory to suggest both that the misunderstanding

of Kant was essential for the development of biology and that Kant had no influence on the development of biology. Rather this required the consideration of alternative conceptions of influence that could account for Kant's influence on biology without presupposing that Kant's thinking was compatible with this subsequent development.

Bloom's account of poetic influence explained how poets creatively correct previous poets through acts of misprision to establish their own poetic identities. This showed how the source of influence can differ significantly from its effect. Also, Feyerabend utilised the distinction between the context of justification and the context of discovery[86] to explain how scientific theories first begin from the 'discovery' of principles by *arational* means that are then subject to justification. These accounts provided the basis for an alternative explanation of Kant's influence on the development of biology despite the incompatibility between transcendental idealism and naturalism. This conception of influence as inclusive of misunderstanding and misprision was essential for my subsequent discussions of the context of the emergence of transcendental idealism and its development on philosophy of science in the British Isles. Central to both discussions was the idea that the differences and potential incompatibilities between naturalism and transcendental idealism did not entail that they have not been reciprocally influential on one another.

Kant regarded his account of transcendental idealism as an extension of the problems identified by Hume. Approaching Kant's philosophy from the perspective of Hume provided an accessible way of introducing some of the motivations that contributed to the development of transcendental idealism. I presented transcendental idealism as developing from important modifications to Humean scepticism. Kant's interpretation of Hume was based on a misunderstanding of Hume's distinction between relations of ideas and matters of fact. Kant regarded the former as logical certainties that were true independent of experience, whereas Hume regarded these as psychological certainties that required justification from experience. Kant interpreted Hume as protecting his account of mathematics from the scepticism directed toward matters of facts pertaining to the rational justification of metaphysical causality. In this sense, Kant was not attempting to offer a refutation of Hume's philosophy on Hume's own terms. Kant conceded that Hume was correct to deny the possibility of a rational justification of

[86] This distinction was originally developed by Reichenbach (1938).

causality on the presupposition that objects of experience are regarded as objects in themselves (CPrR 5:53). He transformed Hume's philosophy into the foundations of transcendental idealism through his reorientation of the conditions of knowledge toward objects of appearances rather than objects as they are in themselves. He argued that Hume would have discovered the possibility of synthetic *a priori* truths if he had not protected his account of mathematics from his scepticism (CPR B19). In this sense, Kant regarded transcendental idealism as developing from Hume's empirical scepticism.

Crucially, Kant's account of Hume is based on a misunderstanding of Hume's relations of ideas. Hume argued that relations of ideas were psychologically certain, rather than logically certain. Both relations of ideas and matters of fact require experience for justification, but one experience is sufficient for the rational justification of relations of ideas. In contrast, it is not possible to justify matters of fact rationally, rather they are justified in accordance with custom or habit. This reveals the deep similarity between the projects of Kant and Hume which had remained unknown to Kant. Both were concerned with the possibility of establishing *a priori* certainty from the basis of synthetic experience. For Hume, this was restricted to relations of ideas, whereas for Kant the possibility of establishing synthetic *a priori* certainty in relation to mathematics revealed the broader separation of the conditions of knowledge of appearances from the conditions of knowledge of things in themselves. This reversed Hume's claim that philosophy is embarrassed by its inability to provide justification for its reliance on habit. Rather Kant argued that Hume's appeal to habit was mistaken as he presupposed that objects of experience were objects in themselves.

Kant regarded Hume's philosophy as the censorship of reason which exposed the impossibility of a rational justification for metaphysical knowledge. However, he merely replaced the rational justification of metaphysical arguments with an appeal to habit. In this sense, Kant regarded transcendental idealism as the complete maturation of Hume's philosophy as it relocated necessity in the conditions of experience rather than in objects in themselves. Kant situated Hume's philosophy in the broader context of the system of transcendental idealism. Guyer accurately describes Kant's intention as replacing Hume's empirical scepticism with 'a substantive theory of the imperfection of our knowledge of natural law' (Guyer, 2017, p.67). This has significant implications for understanding Kant's account of knowledge of scientific laws. For Kant, our knowledge of scientific laws transcend any possible experience and therefore can only be justified in accordance

with regulative ideas. These regulative ideas project unity onto nature that guides experience, yet experience cannot sufficiently prove that nature in itself is unified. Kant describes this in relation to the optical illusion of the *focus imaginarius* which was intended to illustrate how the unity of nature is a necessary requirement for scientific enquiry, yet this unity cannot relate to objects independent of experience. Kant's claim concerning the compatibility of theoretical and practical philosophy is dependent on this account of scientific enquiry as derived from regulative principles of reason. His account of freedom required that knowledge related only to the appearance of the objects and not objects in themselves. This allowed Kant to argue that reason can apply laws in two distinct ways: theoretically and practically. For the former, we consider the appearances of nature in accordance with the regulative principle of unity. In the context of Kant's moral philosophy, we do not apply regulative laws to nature, rather we establish universal laws (or maxims) to govern action.

These aspects of Kant's philosophy are related to his transformation of Hume insofar as the separation of the conditions of knowledge of appearance from the knowledge of objects in themselves is essential for the compatibility between the theoretical and practical applications of reason. Kant's extension of Hume's scepticism to mathematics revealed to Kant that *a priori* certainty could be deduced as a necessary condition of experience which does not relate to objects in themselves. This interpretation of Kant's philosophy as both developing from, and an extension of, the foundations of Hume's philosophy presents transcendental idealism as a continuation of Hume's sceptical method. Interpreting aspects of both Kant's theoretical and practical philosophy as developing from his misunderstanding of Hume could be explored in further research. In the context of this thesis, transcendental idealism was introduced as developing from the problems raised by Hume to present a more accessible account of the counterintuitive features of transcendental idealism. Further research is needed to identify the extent of Hume's influence on the development of Kant's practical philosophy. I suspect this would offer support to the compatibility between Kant's theoretical and practical philosophy that has been developed throughout this thesis.

I compared Kant's account of scientific knowledge with contemporary disputes regarding the status of the laws of nature. The two accounts that were considered were Bhaskar's account of critical realism and Cartwright's account of nomological pluralism. Both argued that their accounts were supported by transcendental arguments, yet their

accounts are incompatible with one another. The difference between their accounts can be understood in terms of the distinction between rationalism and empiricism. For Bhaskar, the idea that nature is governed by intransitive universal laws is a precondition for the possibility of science, whereas for Cartwright there is little empirical evidence for the existence of such laws. Both supported the idea of a unified science, yet their conceptions of what this unified science entailed significantly differed. For Bhaskar this unity was established at the level of intransitive laws that were a precondition for the possibility of science, whereas for Cartwright the unity of nature was comprised of the patchwork of context-specific laws that are constituted by powers assembling and reassembling themselves. This entailed the denial of intransitive laws that act independently from their manifestations. Rather laws relate to the context-specific conditions in which regularity is established. The difference between Bhaskar and Cartwright forms a dichotomy which cannot be resolved. From the perspective of Kant's critical philosophy, the problem for both sides of this dichotomy is that they appeal to transcendental arguments to support metaphysical claims that go beyond the remit of experience. The problem with these accounts when considered from the perspective of transcendental idealism is they both make assumptions about the relationship between metaphysics and epistemology that cannot be sufficiently supported. The idea of scientific laws as regulative rational projections entails that scientific enquiry must proceed *as if* nature contained universal laws, but we must also recognise that experience could never offer justification for the ontological existence of these laws.

My third chapter examined Kant's influence on the development of biology in the British Isles by focusing on Kant's influence on Whewell's philosophy of science. Kant's influence on Whewell was threefold, he revealed: the importance of the active powers of the mind for knowledge, the idea that knowledge was the product of two irreducible sources, and the requirement for science to regard nature as unified. In the context of the relationship between transcendental idealism and naturalism it is important to emphasise that Kant thought that it was necessary to establish the source of necessity non-naturalistically. In contrast, Whewell was dissatisfied with the implications of transcendental idealism for scientific enquiry; he sought to re-establish these principles in accordance with naturalism once again. Whewell rejected Kant's argument that possible knowledge was limited to the fixed categories of the understanding and did not relate to things in themselves. Whewell replaced Kant's account of knowledge as

intuitions subsumed under categories with the fundamental antithesis between thoughts and things. Thoughts included both categories and intuitions and things related to objects in themselves. Whewell developed his account of facts and theories from this fundamental antithesis. A fact corresponds to cases where a thought and a thing are in complete agreement, whereas a theory is a thought that extends beyond the thing. Science is the process of developing new theories that can adequately colligate facts or bring them under a rule. The ultimate expression of the truth of a theory is established when a theory can offer an explanation of facts belonging to different classes. Whewell termed this the consilience of inductions.

Kant's influence on Whewell can be understood in the context of the account of influence developed in Chapter One. Since Whewell did not make any reference to the questions that were specific to Kantian philosophy, it has been argued that this is evidence against Kant's influenced on Whewell (cf. Fisch, 1991, p.105). In contrast, I argued that Whewell had not discussed these issues because of his dissatisfaction with Kant's account of scientific knowledge, not because he had not influenced Whewell. One fundamental difference between the philosophies of Whewell and Kant was their differing justifications for the presupposition that scientific enquiry must be considered as unified. Whewell explains the consilience of inductions as a method by which *a posteriori* knowledge becomes *a priori* because there has been no example in history where consilience has been achieved and then been later proven false. In contrast, Kant argued that reason demanded the unity of nature as a regulative principle for the possibility of scientific enquiry. It was not possible for *a posteriori* knowledge that was guided by this regulative principle to ever achieve *a priori* certainty of natural laws as this unity itself was a presupposition at the level of ideas. Whewell's justification for the consilience of nature and the resolution of the fundamental antithesis between thoughts and things appealed to theology. Kant would have rejected this theological resolution as he denied any theoretical knowledge of God's existence.

The conception of consilience has gone through various stages; for Kant it was a regulative demand of reason, for Whewell it was primarily a methodological principle for judging the correctness of a theory (albeit supported theologically). In contemporary philosophy of science, the principle of consilience has taken a metaphysical turn. Philosophers such as Wilson and Mackie have argued that biology must provide an explanation of ethics. If this is not achieved, then the possibility of a universal consilience

fails. In contrast, Whewell regarded the explanatory virtue of consilience as residing in its unexpectedness. Whewell's account of consilience did not demand that it provide a complete reductive account of nature, but only that the demonstration of consilience is support for the correctness of a theory.

Some interpretations of Kant suggest that there are potential benefits in considering Kant's critical philosophy as offering support to the methodologies of contemporary philosophy of science. For instance, Kitcher suggests that a Kantian philosophy of science could be beneficial if Kant's commitment to *a priority* as a condition for science is rejected. Instead, he argues that we should regard ourselves as choosing the best account of science from the range of possible available alternatives. That is, our best scientific knowledge can only be derived from the inherited projected orders of nature that 'have been generated by the systems of our ancestors' (Kitcher, 1986, p.222). This emphasis on the historical inheritance of previous scientific accounts stands in tension with some fundamental principles of transcendental idealism. Many of the previous scientific accounts that we inherit from our ancestors are committed to transcendental realist conceptions of reality that treat the appearance of objects as identical to objects in themselves. *Pace* Kitcher, Kant's account of science could distinguish between scientific accounts that were compatible with transcendental idealism and those that are not. It could not provide further conditions for choosing better and worse theories because it would be impossible for scientific accounts that were compatible with transcendental idealism to conflict with each other.

Breitenbach's and Choi's account of unified pluralism suggested Kant's principle of regulative unity could be beneficial for contemporary pluralist accounts of science. This regulative unity requires science to develop in accordance with the principles of collaboration and cooperation. They argued that scientists must first agree on the problems of science and understand how these different avenues of enquiry aid us in achieving a better understanding of the same natural world. The aim for an account of scientific method that promotes communication and collaboration is an admirable project. The idea that this could be established by incorporating aspects of Kant's critical philosophy into contemporary philosophy of science demonstrates the principles by which Kant's philosophy could offer support. However, there is an underlying tension between Kant's principle of the regulative unity of science and contemporary naturalist philosophers of science because the regulative unity of nature requires the acceptance of

broader aspects of transcendental idealism. For Kant, the regulative unity of nature is a direct consequence of his denial of knowledge of objects in themselves. The regulative unity of nature is demanded by reason because scientific enquiry does not relate to objects in themselves, but merely to our ability to project order onto nature as a guideline for scientific enquiry. This would not be accepted by most contemporary philosophers of science. This was demonstrated by examining the alternative ontological accounts of scientific laws discussed in Chapter Two. Both Bhaskar and Cartwright agreed that nature more generally does not conform to the regularity achieved in scientific experiments, yet they disagreed about what this entailed for the ontological status of laws. From the perspective of transcendental idealism, both accounts attempted to derive alternative metaphysical conclusions about the conditions of objects independent of experience from appearances. This dispute between alternative transcendental realist accounts could not be resolved unless both philosophers accepted that their metaphysical conclusions were not empirically supported. They are not empirically supported because the properties of objects in themselves cannot be derived from appearances.

Further research is needed to examine the extent to which alternative justifications for the unity of science—in relation to both scientific pluralism and monism—could be supported by Kant's critical philosophy. If philosophers of science are not amenable to the separation of the conditions of knowledge of appearances from knowledge of objects in themselves, then this will be problematic for their potential compatibility with Kant's account of the regulative unity of nature. It might be argued that philosophy of science requires a more radical Kantian shift because those philosophers lack sufficient justification for their ontological claims regarding nature independent of experience. If they were to renounce their ontological commitments pertaining to metaphysical truths independent of experience, this would make it possible for the unity of science to be established as a regulative principle.

Chapter Four examined the influences that contributed to the emergence of Darwin's account of natural selection. I considered the extent to which Kant indirectly influenced the development of Darwin's *Origin of the Species* through his influence on Whewell's conception of consilience. Importantly, Whewell's account of biology significantly differed from Kant's account of teleological judgment. For Whewell, the design of biological organisms both justified, and was warranted by, the divine design of nature. In contrast, Kant was more critical of our warrant to view nature as the source of

purposiveness. Kant distinguished between external and internal forms of purposiveness. External purposiveness related to the ways that nature can be used for our ends and the ends of other creatures. These relative purposes are different in kind to the internal natural purposiveness which organisms are judged to possess. This distinction is important in the context of Ruse's interpretation of Darwin which appealed to Kant's conception of teleological judgment as offering support to Darwin's account.

My discussion of the influences on Darwin's account focused on the philosophies of science developed by Herschel and Whewell. Their influences were explained in the context of Sober's separation of two logically distinct arguments in Darwin's *Origin*: the argument from common ancestry and the argument for natural selection. The argument from common ancestry was more closely related to Whewell's conception of consilience as evidence for common ancestry was supported by many different biological disciplines. In contrast, the argument for natural selection was based on an analogical argument with artificial selection. This appeal to the analogical relation between artificial and natural selection was more closely aligned to the methodology of Herschel. Herschel argued that analogical arguments form the basis for *vera causa* principles (or true causes). For Herschel, if the analogy between two phenomena is very striking, then this serves as justification for ascribing the known cause of one to the unknown cause of the other.

The extent to which Kant indirectly influenced Darwin through Whewell is difficult to establish because of unresolved disputes concerning the extent of Herschel's and Whewell's influence on Darwin's methodology. For instance, Ruse minimises the difference between Herschel and Whewell, combining them under the single 'Herschel-Whewell philosophy of science' (Ruse, 1975, p.166). The difference between the philosophies of Herschel and Whewell is that consilience alone is sufficient to demonstrate the truth of a theory for Whewell. There are aspects of Darwin's account that can only be justified in relation to Whewell's conception of consilience. For instance, Darwin asserts that if several classes of facts can be explained in accordance with common ancestry, then this is sufficient justification for accepting the truth of the matter without hesitation 'even if it were unsupported by other facts or arguments' (Darwin, 2003, p.378). Moreover, the reception of Darwin's theory suggested that it was understood in accordance with a Whewellian, rather than Herschelian conception of *vera causa* (Waters, 2003). In contrast, others argued that Darwin could not have been significantly influenced by Whewell's account of consilience as Darwin formulated his

account prior to the publication of Whewell's theory. The range of alternative interpretations regarding the possible influences on Darwin's methodology creates a substantial difficulty for identifying Whewell's direct influence. Consilience clearly played a role in the justification of Darwin's theory, but the extent to which this supportive or formative has remained beyond the remit of my investigation.

Whewell transformed Kant's transcendental idealism into a naturalism that served as the basis for his philosophy of science. Whewell's account of consilience probably influenced the development of Darwin's *Origin*. Moreover, the difference between Whewell's and Kant's conceptions of biology meant that Darwin was not aware of the aspects of Kant's teleological judgment that could offer a critical response to his theory. For instance, Kant developed critical arguments exposing the differences between internal and external purposes in the context of transcendental idealism. This was contrasted with Darwin's account of the similarity between natural and artificial selection. The prevalent interpretation of the relation between artificial and natural selection is that Darwin was proposing an analogical relation between the two. Malthus provided Darwin with the means for explaining how natural selection could outstrip its analogical counterpart. Kant's discussion of the difference between external and internal forms of purposiveness raises an important issue for the analogy between artificial and natural selection. Kant noted that humans use entities for their own ends, but this kind of purposiveness is only external and cannot be used to justify the internal purposiveness of organisms. Kant regarded external and internal purposiveness as different in kind because they emerged from essentially different sources. In contrast, Darwin's analogy between artificial and natural selection is not concerned with the sources of purposiveness. The sources of purposiveness for natural and artificial selection are different, yet both can produce phylogenetic changes in species. Thus, Darwin argued that natural and artificial selection belong to the same power (Darwin, 2003, p.162).

Darwin was influenced by Paley's analogy between organisms and artefacts. For Paley, our knowledge of the design of organisms was analogous to finding a watch on a heath and inferring that it is the product of design. Kant denies this analogy between organisms and artefacts on the basis that the purposiveness of organisms is judged to be internal whereas the purposiveness of artefacts is always located in intentions which are external. These differences between Darwin and Kant are significant because some contemporary philosophers of biology have appealed to Kant's conception of teleological

judgment in support of Darwin. Ruse interprets Darwin's and Kant's accounts of the organism as compatible. For Ruse, the concept of design can be heuristically applied to our experience of organisms to allow us to enquire into questions pertaining to the purposes that have caused certain biological traits to develop. Ruse regards this as compatible with Kant because it means that we consider organisms *as if* they are the product of design, without needing to claim that they *are* the product of design. This allows for the possibility of viewing nature as designed without requiring a designer. This account is not compatible with Kant's conception of teleological judgment. Kant does not regard our ability to view nature *as if* it were the product of design as heuristic in the sense that it is possible to separate our conception of the organism from its design. The organism is regarded *as if* it were purposive because we lack sufficient justification for claiming that this purposiveness is in nature; rather it can only be justified in accordance with judgment. *Pace* Ruse, teleological judgments are not heuristic in the sense that we can choose to view organisms in accordance with metaphorical final causes. For this reason, Richards criticises Ruse for failing to take the role of the metaphor seriously as he assumes these metaphors can be eliminated while leaving the theory intact (Richards, 2004, p.37). In contrast, Richards argues that Darwin is better understood in the context of German Romanticism which can account for natural selection as an intentional benevolent selecting force that selects for the good of the organism. Richards argued natural selection was not a mechanical non-intentional selecting force, rather it was a teleological and altruistic force.

The notion that the organism requires us to conceive of it in accordance with design which can be set aside once we attain a better understanding of its non-intentional mechanical causes has continued to persist in some accounts of contemporary philosophy of biology. This was discussed in relation to Dennett's adaptationism. For Dennett, our ability to regard nature as designed requires us to adopt an intentional stance toward nature. Ratcliffe argued that the irreducibility of design required for the intentional stance reveals why Dennett's account requires something like Kant's account of teleological judgment as a non-naturalistic ground. *Pace* Ruse and Dennett, it is not the *dispensability* of design within nature—but rather its *indispensability*—that signifies the need to introduce Kant's account of teleological judgment in support of biology. This presents a very different perspective on the incompatibility between transcendental idealism and biological naturalism. If nature is considered as exemplifying purpose, then the ability to

perceive nature in accordance with purpose requires an explanation. If we must view organic nature in accordance with teleology, then we must either explain how nature itself is teleological or how it is possible for us to conceive of design in accordance with a non-naturalistic ground. In contrast, some contemporary philosophers of biology have suggested that it is not necessary to consider organisms as the product of design. Nicholson argued that the account of the organism as exhibiting design emerges from the tendency to view organisms as machines. He argued organisms should be understood in the context of inorganic unintentional dissipative structures such as eddies or whirlpools. Like whirlpools, organisms are continually renewing their parts and their wholes to maintain their organisation. Machines do not continuously renew all their parts, rather their change in material is directed toward functions that the machine performs. As these inorganic dissipative structures are not the product of design, and organisms are just complex manifestations of dissipative structures, it follows that organisms are also not the product of design. Rejecting the conception of organisms as in some way products of design comes at the cost of accurately being able to demarcate living and non-living dissipative structures. For instance, Kauffman argued that the storm system on Jupiter known as the 'Great Red Spot' could be regarded as a living system. In relation to Kant's philosophy, various scholars have suggested that the solution to Kant's antinomy between teleology and mechanism is provided by advances in scientific knowledge relating to thermodynamics. In contrast, I argued that Kant's account of scientific laws as a regulative unity which is projected onto nature by the subject reveals why Kant could not consider thermodynamics as a constitutive ontological law of nature.

Chapter Five examined appeals to various aspects of Kant's philosophy in contemporary philosophy of science. This was developing on Zammito's claim that Kant's philosophy is not helpful for contemporary philosophers of biology because of the broader inconsistencies between transcendental idealism and naturalism (Zammito, 2006, p.766). Despite the incompatibilities between naturalism and transcendental idealism that Zammito correctly identifies, this does not change the fact that philosophers of biology have appealed to Kant's philosophy. This chapter considered specific ways that Kant's philosophy is either similar to, or has directly influenced, contemporary philosophers of biology. The critical examination of these theories allowed us to understand both the role of Kant's philosophy in their development, and the broader extent of their compatibility or incompatibility with transcendental idealism.

I examined Durpré's appeal to Kant's conception of freedom in support of his own account of biological freedom. It would be misleading to suggest that Kant directly influenced Dupré's account of freedom, they are similar insofar as both emphasise the importance of human agency. For Dupré, freedom is not related to the ability of finite rational beings to establish maxims in accordance with reason, rather he understands the difference between free and unfree actions as differing in degrees of causal efficacy. Humans are the densest concentration of causal powers that we have found.

Dupré interprets Kant as a causal determinist at the level of laws. Kant is a determinist at the level of appearances, but Kant's account of scientific laws is not deterministic. Knowledge of scientific laws is based on regulative projections of reason. This is central for Kant's account of the compatibility between freedom and nature. The possibility of freedom requires that scientific knowledge does not determine objects in themselves. Natural necessity can only pertain to the individual understood as a phenomenal being in accordance with space and time. When acting in accordance with practical reason, the individual does not stand under these temporal conditions. This was explained in relation to the distinction between categorical and hypothetical imperatives. The means and ends of categorical imperatives are not temporally distinct, whereas the means and ends of hypothetical imperatives are temporally distinct. It follows from the temporality of hypothetical imperatives that they are not expressions of free action. This led to a discussion of the relation between moral and natural laws. Kant describes laws as all alike insofar as they impose an intelligible structure. Hence Kant argues that 'natural law serves only as a *type* of freedom' (CPrR, 5:70). The compatibilism between freedom and nature is that both are understood as rational projections. For theoretical reason, these are regulative laws that guide scientific enquiry. For practical reason, these are moral maxims (i.e. categorical imperatives) that guide human action.

Dupré emphasises the importance of biological freedom to argue that biological explanations that focus on genetic reductivism overlook how developments at the societal level have been the source of major evolutionary change. He considers access to universal healthcare and education as examples of this. Kant's political philosophy can be interpreted as offering support to Dupré's account. Kant describes how we are obligated to develop a state which offers support to members of society who are unable to support themselves. Dupré does not explicitly advocate that society ought to be developing in accordance with socially progressive principles, but he appeals to examples which have

positively impacted society. If the biological sciences *ought* to be developing toward research that is directed toward socially progressive outcomes, then Kant's political philosophy can potentially offer support for this.

Kant's influence on contemporary accounts of biological autonomy was also examined. His account of teleological judgment has been appealed to in support of principles that demonstrate how biological entities manifest biological closure and possess agency. Kauffman described these entities as "Kantian wholes" which have the irreducible properties of self-recreation which is achieved by engaging in work cycles. A work cycle describes how entities utilize energy from their environments to perform an activity or function. The parts and the whole of the entity must be organised in a way that allows it to start another cycle of work once the previous work cycle has been completed. Organic work cycles establish their own biological closure internally, whereas non-organic work cycles are constructed from pre-existing external parts. The former emerges from a process of internal *differentiation*, the latter from external *aggregation*. This resonates with Kant's distinction between machines and organisms. The former possess a motive force, whereas the latter possess a formative force. This formative force explains how organic entities are judged to continually self-organise their parts and their whole, in contrast machines are organised externally.

Kant's influence on the development of contemporary accounts of biological autonomy is unwarranted because his account of teleological judgment must be understood in the broader context of transcendental idealism. According to Guyer, 'it is only our awareness of the freedom of our own purposiveness that leads us to conceive of the purposiveness of organisms as necessitating a fundamental split between the teleological and mechanical views of nature' (Guyer, 2001, p.264). For Kant, our ability to judge nature teleologically is made possible by our capacity for practical reason and moral teleology. This aspect of Kant's account of teleological judgment is generally overlooked. Ginsborg argues that Kant's account of teleological judgment is not related to practical reason because the judgments of physical teleology do not reveal that the entity is good or rationally desirable (Ginsborg, 2015, p.252). Breitenbach has argued that Kant's appeal to our rational capacities should be extended beyond the conception of moral reason to include the 'capacity for reason as a whole' (Breitenbach, 2014, p.136). In contrast, I argued the analogy should be understood in a more limited sense as relating specifically to moral teleology. Kant argues that moral teleology would be unaffected

even if no appearances manifested physical teleology. However, physical teleology offers corroboration for moral teleology because it displays 'something analogous to the (moral) ideas of reason' (CJ 5:479). I argued this supported the conception of Kant's philosophy as advocating consilience at the level of *faculties*, rather than *facts*. This exposes an incompatibility between Kant's account of physical teleology and contemporary theories of biological autonomy. They do not regard self-organisation as a product of judgment that is made possible by practical reason. Instead, they regard these properties as belonging to the entities themselves independent of perception.

Finally, Kant's influence on the development of immunology was examined. The immunological conception of the self borrowed from Kant's account of the self. Tauber described Kant as the 'consummate architect of the modern self as an autonomous and self-determining subject' (Tauber, 1994, p.290). He argued that the immune self possessed self-knowledge which was available in the immediacy of embodiment. I argued this fallaciously equivocated between two distinct senses of the self in Kant's philosophy: the transcendental unity of apperception, and the self as the product of teleological judgment. Kant did not regard the former as resulting in self-knowledge; according to Kant, 'consciousness of the self is very far from being a knowledge of the self' (CPR B158). Kant's account of the self as a product of teleological judgment did not result in knowledge of the self as such judgments were grounded supersensibly.

Following this, I examined Pradeu's continuity theory which suggested that the self-metaphor is no longer required for immunologists. The continuity theory explains how immune identity is open to its environment and the organism is comprised of many endogenous and exogenous entities such as microbes. Pradeu distinguishes biological individuality in two forms: physiological and evolutionary individuals. Physiological individuals are organisms that possess an immune system. Evolutionary individuals refer to any biological individual that is the product of evolutionary pressures. These can be entities below the level of physiological individuals (genes, chromosomes), physiological individuals themselves, or above the level of physiological individuals (populations). Physiological individuals cannot always be considered as evolutionary individuals because they can form associations with entities from different genetic lineages if those entities are tolerated by the organism's immune system. This was supported by recently research that suggested that FMT is an effective treatment for *c.diff* infections.

Pradeu considered the conception of physiological individuality as originating from Kant's conception of teleological judgment. His account is similar to Kant's insofar as both argue that organisms are self-organised and self-organising entities. The difference is that Pradeu locates much of the self-organising capacity of organisms to physical biochemical functions of the immune system. This requires that the immune system is understood as acting at the level of the organism as a whole and at the level of the parts simultaneously. I argued that the idea that immunity acts at both these levels is incompatible from the perspective of transcendental idealism. It requires that the particular biochemical responses which are understood at the level of efficient causation are united with the understanding of the organism as a whole at the level of final causation. Kant's account of teleological judgment can offer support to this aspect of the continuity theory if it were to concede that the organism and the immune system are inseparable from judgment. In this sense, Pradeu extends the scope of the entities that can be understood as physiological individuals because he shows that various entities beyond the phenomenal experience of organisms possess biochemical responses which can be judged as immune systems. In this sense, immune systems are formed of biochemical responses that can be understood in terms of efficient causation, but they also must be judged teleologically to appreciate their capacity for self-organisation of the organism as a whole.

Overall, this thesis has revealed that Kant's philosophy has been a significant source of influence for both the development of biology and contemporary philosophers of biology. The incompatibilities between biological naturalism and transcendental idealism reveal that in many cases, Kant's influence on these scientific developments cannot be sufficiently justified from the perspective of biological naturalism. I have demonstrated how Kant's philosophy was influential in the following cases: Whewell's conception of consilience, the design of nature understood as a heuristic principle, contemporary conceptions of biological autonomy, and the development of immunology. In my discussion of these cases, I have revealed how philosophers of biology have appealed to Kant to resolve issues that go beyond their commitments to biological naturalism. Alternatively, some interpretations of Kant have argued that principles from Kant's philosophy such as the regulative demand of reason can offer support to contemporary philosophy of science. The project of developing an account of scientific methodology that is broadly compatible with Kant's critical philosophy is an important

project and one that I aim to develop in future research. A Kantian philosophy of science could only offer justification for the regulative demand of reason if it was consistent with the broader aspects of transcendental idealism. It would require the separation of the conditions of knowledge of appearances from objects in themselves. This would show how scientific investigation requires the regulative principle of unity without imposing that this unity related to any object independent of experience. I have explored some ways in which Kant's philosophy could offer support to contemporary philosophers of biology, however I argued that this compatibility would require a revision of their metaphysical commitments to establish a compatibility with the principles of transcendental idealism.

References

What Does Anschauung Mean? (1892) *The Monist*, 2(4), pp.527-532

Allais, L. (2015) *Manifest Reality: Kant's Idealism and his Realism*. Oxford: Oxford University Press

Allen, C. and Beckoff, M. (1995) Biological Function, Adaptation, and Natural Design. *Philosophy of Science* 62, pp. 609– 622

Allison, H. (1969) Transcendental Idealism and Descriptive Metaphysics. *Kant-Studien,* 60, pp.216-33

Allison, H. (1990) *Kant's Theory of Freedom*. Cambridge: Cambridge University Press

Allison, H. (1996) *Idealism and Freedom: Essays on Kant's Theoretical and Practical Philosophy.* Cambridge: Cambridge University Press

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

Allison, H. (2008) *Custom and Reason in Hume: A Kantian Reading of the First Book of the Treatise.* Oxford: Oxford University Press

Aristotle. (1908) *Metaphysics.* Translated by Ross, W, D. Oxford: Oxford University Press

Avrameas, S. (1991) Natural autoantibodies: from 'horror autotoxicus' to 'gnothi seauton'. *Immunology Today*. 12(5), pp.154-159

Ayala, F. (2008) From Paley to Darwin: Design to Natural Selection. *Back to Darwin: A Richer Account of Evolution*. Edited Cobb, J. Cambridge: William B. Eerdmans Publishing Co, pp.50-75

Beck, L, W. (1978) A Prussian Hume and a Scottish Kant. In *Essays on Kant and Hume*. London: Yale University Press, pp.111-129

Berlin, I. (1998) The Concept of Scientific History. In *The Proper Study of Mankind*. Edited by Hardy, H. and Hausheer. R. London: Pimlico, pp.17-58

Bhaskar, R. (1989) *Reclaiming Reality: A Critical Introduction to Contemporary Philosophy.* London: Verso

Bhaskar, R. (2008) *A Realist Theory of Science*. London: Verso

Bloom, H. (1997) *The Anxiety of Influence: A Theory of Poetry*. 2nd Edition. Oxford: Oxford University Press

Bouchard, F. (2008) Causal Processes, Fitness, and the Differential Persistence of Lineages. *Philosophy of Science*, 75(5), pp.560–570

Bouchard, F. (2010) Symbiosis, lateral function transfer and the (many) saplings of life. *Biology and Philosophy*, 25(4), pp.623-641

Bouchard, F. (2013) What is a Symbiotic Superindividual and how do you Measure its Fitness? In *From Groups to Individuals: evolution and emerging individuals*. Edited by Bouchard, F. and Huneman, P. Cambridge: The MIT press, pp.243-264

Breitenbach, A. (2009) Teleology in Biology: A Kantian Perspective. In *Kant Yearbook 01/2009 Teleology*. Edited by Heidemann, D. Berlin: De Gruyter, pp.31-56

Breitenbach, A. (2014) Biological Purposivenss and Analogical Reflection. In *Kant's Theory of Biology*. Edited by Goy, I. and Watkins, E. Berlin: De Gruyter, pp.131-148

Breitenbach, A. and Choi, Y. (2017) Pluralism and the Unity of Science. *The Monist*, 100(3), pp.391-405

Butts, R. (1993) *Historical Pragmatics: Philosophical Essays*. Dordrecht: Kluwer Academic Publishers

Butts, R. (1994) Induction as Unification: Kant, Whewell, and Recent Developments. In *Kant and Contemporary Epistemology*. Edited by Parrini, P. Dordrecht: Kluwer Academic Publishers, pp.273-290

Cartwright, N. (1999) *The Dappled World: A Study into the Boundaries of Science*. Cambridge: Cambridge University Press

Clarke, E. (2010) The Problem of Biological Individuality. *Biological Theory*, 5(4), pp.312-325

Clarke, E. and Okasha, S. (2013) Species and Organisms: What are the Problems? In *From Groups to Individuals: Evolution and Emerging Individuality.* Edited by Bouchard, F. and Huneman, P. Cambridge: The MIT press, pp.55-76

Clarke, S. (2010) Transcendental Realisms in the Philosophy of Science: On Bhaskar and Cartwright. *Synthese*. 173(3), pp.299–315

Coleman, W. (1977) *Biology in the Nineteenth Century: Problems with Form, Function, and Transformation.* Cambridge: Cambridge University Press

Combes, C. (2001) *Parasitism: The Ecology and Evolution of the Intimate Interactions*. Translated by Buron, I. and Connors, V. Chicago: University of Chicago Press

Darwin, C. (2003) *On the Origin of the Species*. Edited by Carroll, J. Plymouth: Broadview

Davidson, D. (1973) On the Very Idea of a Conceptual Scheme. *Proceedings and Addresses of the American Philosophical Association* 47(1973-4), pp. 5-20

Dennett, D. (1995) *Darwin's Dangerous Idea.* London: Penguin Books

Ducheyne, S. (2010) Fundamental Questions and Some New Answers on Philosophical, Contextual, and Scientific Whewell. *Perspectives on Science*, 18, pp.242–72

Ducheyne, S. (2011) Kant and Whewell on Bridging Principles Between Metaphysics and Science. *Kant-Studien.* 102, pp.22–45

Dupré, J. (1993) *The Disorder of Things: Metaphysical Foundations of the Disunity of Science*. Cambridge: Harvard University Press

Dupré, J. (2001) *Human Nature and Limits of Science.* Oxford: Clarendon Press

Dupré, J. (2012) *Processes of Life: Essays in the Philosophy of Biology*. Oxford: Oxford University Press

Dupré, J. and Guttinger, S. (2016) Viruses as living processes. *Studies in History and Philosophy of Biological and Biomedical Sciences*, 59, pp.109-116

Dupré, J. and Nicholson, D. (2018) A Manifesto for a Processual Philosophy of Biology. In *Everything Flows: Towards a Processual Philosophy of Biology.* Edited by Nicholson, D. and Dupré, J. Oxford: Oxford University Press, pp. 3-45

Engstrom, S. (2017) Knowledge and its Object. In *Kant's Critique of Pure Reason: A Critical Guide*. Edited by O'Shea, J. Cambridge: Cambridge University Press, pp.28-45

Feyerabend, P. (1970) Consolations for the Specialist. In *Criticism and the Growth of Knowledge.* Edited by Lakatos, I. and Musgrave, A. Cambridge: Cambridge University Press, pp.197-230

Feyerabend, P. (1978) *Against Method*. London: Verso

Fisch, M. (1985) Necessary and Contingent Truth in Whewell's Antithetical Theory of Knowledge. *Studies in History and Philosophy of Science,* 16(4), pp. 275-314

Fisch, M. (1991) *William Whewell Philosopher of Science*. Oxford: Oxford University Press

Floyd, J. (2003) The fact of Judgment: The Kantian Response to the Humean Condition. In *From Kant to Davidson: Philosophy and the Ideal of the Transcendental*. Edited by Malpus, J. London: Routledge, pp.22-47

Friedman, M. (2002) Kant, Kuhn, And The Rationality Of Science. *Philosophy of Science,* 69(2), pp.171-190

Gardner, S. (1999) *Kant and the Critique of Pure Reason*. London: Routledge

Ginsborg, H. (2015) *The Normativity of Nature: Essays on Kant's Critique of Judgement*. Oxford: Oxford University Press

Godfrey-Smith, P. (2014) *Philosophy of Biology*. Princeton: Princeton University press.

Gottenbarn, D. (1974) Kant, Hume and Analyticity. *Kant-Studien,* 65(1-4), pp.274-283

Gould, S. and Lewontin, R. (1979) The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme. *Proceedings of the Royal Society of London,* B 205 pp.581–98.

Gould, S. and Vrba, E. (1998) Exaptation–A Missing Term in the Science of Form. In *The Philosophy of Biology*. Edited by Hull, D. and Ruse, M. Oxford: Oxford University Press, pp.52-71

Grant, M. and Mitton, J. (2010) Case Study: The Glorious, Golden, and Gigantic Quaking Aspen. *Nature Education Knowledge* 3(10)

Grene, M. and Depew, D. (2004) *The Philosophy of Biology: An Episodic History*. Cambridge: Cambridge University Press

Guyer, P. (2001) Organisms and the Unity of Science. In *Kant and the Sciences*. Edited by Watkins, E. Oxford: Oxford University Press, pp.259-282

Guyer, P. (2006) *Kant.* London: Routledge

Guyer, P. (2007) Debating Allison on Transcendental Idealism. *Kantian Review*, 12(2), pp.10-23

Guyer, P. (2008) *Knowledge, Reason, and Taste: Kant's Response to Hume*. Princeton: Princeton University Press

Guyer, P. (2017) Imperfect Knowledge of Nature: Kant, Hume, and the Laws of Nature. In *Kant and the Laws of Nature*. Edited by Masimi, M. and Breitenbach, A. Cambridge: Cambridge University Press, pp.49-68

Hacking, I. (2002) *Historical Ontologies.* Cambridge: Harvard University Press

Herschel, J. (1996) *A Preliminary Discourse on The Study of Natural Philosophy*. London: Thoemmes Press

Hooper, L. (2004) Bacterial Contributions to Mammalian Gut *Development. Trends in Microbiology.* 12(3), pp.129-134

Hull, D. (1992) Individuals. In *Keywords In Evolutionary Biology.* Edited by Keller, E, F. and Lloyd, E, A. London: Harvard University Press, pp.180-7

Hull, D. (1989) *The Metaphysics of Evolution.* New York: State University of New York Press

Huneman, P. (2014) Purposiveness, Necessity and Contingency. In *Kant's Theory of Biology.* Edited by Goy, I. and Watkins, E. Berlin: De Gruyter

Kauffman, S. (1995) *At Home in the Universe: The Search for Laws of Complexity*. London: Penguin Books

Kauffman, S. (2000) *Investigations.* Oxford: Oxford University Press

Kauffman, S. (2013) Evolution Beyond Newton, Darwin, and Entailing Law. In *Beyond Mechanism. Putting Life Back into Biology.* Edited by Henning, B. and Scarfe, A. Plymouth: Lexington Books, pp.1-24

Kauffman, S. and Clayton, P. (2006) On emergence, agency, and organization. *Biology and Philosophy*, 21(4), pp.501-521

Kitcher, P. (1986) Projecting the Order of Nature. In *Kant's philosophy of physical science: Metaphysische Anfangsgriinde der Naturwissenschaft 1786-1986*. Edited by Butts, R. Dordrecht: Reidel Publishing Company, pp. 201-235

Korsgaard, C. (1996) *The sources of Normativity*. Cambridge: Cambridge University Press

Kreines, J. (2008) Kant on the Laws of Nature: Laws, Necessitation, and the Limitation of Our Knowledge. *European Journal of Philosophy.* 17(4), pp.527-558

Kuehn, M. (1983) Kant's Conception of "Hume's Problem". *Journal of the History of Philosophy*, 21(2), pp. 175-193

Kuhn, T. (1970a) *The Structure of Scientific Revolutions*. Enlarged edition. Chicago: University of Chicago Press

Kuhn, T. (1970b) Logic of Discovery or Psychology of Research? In *Criticism and the Growth of Knowledge.* Edited by Lakatos, I. and Musgrave, A. Cambridge: Cambridge University Press, pp.1-24

Lakatos, I. (1970) Falsification and the Methodology of Scientific Research Programmes. In *Criticism and the Growth of Knowledge.* Edited by Lakatos, I. and Musgrave, A. Cambridge: Cambridge University Press, pp.91-196

Langton, R. (1998) *Kantian Humility: Our Ignorance of Things in Themselves*. Oxford: Oxford University Press

Laudan, L. (1971) William Whewell on the Consilience of inductions. *The Monist*, 55(3), pp.368-391

Leibniz, G, W. (1989) The Principles of Philosophy, or, the Monadology. In *Philosophical Essays.* Translated by Ariew, R. and Garber, D. Cambridge: Hackett Publishing Company, pp.213-225

Lenoir, T. (1982) *The Strategy of Life: Teleology and Mechanics in Nineteenth Century German Biology*. Dordrecht: Reidel Publishing Company

Lewontin, R. (2000) *The Triple Helix: Gene, Organism, and Environment*. Cambridge: Harvard University Press

Lovejoy, E. (1968) Kant and Evolution. In *Forerunners of Darwin 1745-1859*. Edited by Glass, B. and Temkin, O. and Straus, W. Baltimore: The John Hopkins University Press, pp.173-206

Mackie, J. (1946) A Refutation of Morals. *Australasian Journal of Philosophy*, 24(1-2), pp.77-90

Mackie, J. (1977) *Ethics: Inventing Right and Wrong.* London: Penguin Books

Mayr, E. (1982) *The Growth of Biological Thought: Diversity, Evolution and Inheritance.* Cambridge: Harvard University Press

Mayr, E. (1991) *One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought*. Cambridge: Harvard University Press

McLaughlin, P. (1990) *Kant's Critique of Teleology in Biological Explanation: Antinomy and Teleology* Lampeter: Edwin Mellon Press

Meillassoux, Q. (2008) *After Finitude: An Essay on the Necessity of Contingency*. Translated by Brassier, R. London: Continuum

Mensch, J. (2013) *Kant's Organicism: Epigenesis and the Development of Critical Philosophy.* Chicago: University of Chicago Press

Moreno, A. and Mossio, M. (2015) *Biological Autonomy: A Philosophical and Theoretical Enquiry.* Dordrecht: Springer

Mossio, M. and Moreno, A. (2010) Organisational Closure in Biological Organisms. *History and Philosophy of the Life Sciences* 32(2-3), pp.269-288

Nicholson, D. (2012) The Concept of Mechanism in Biology *Studies in History and Philosophy of Biological and Biomedical Sciences*, 43(1), pp.152-63

Nicholson, D. (2018) Reconceptualizing the Organism: From Complex Machine to Flowing Stream. In *Everything Flows: Towards a Processual Philosophy of Biology.* Edited by Nicholson, D. and Dupré J. Oxford: Oxford University Press, pp. 139-66

Nyhart, L. (1995) *Biology Takes Form: Animal Morphology and the German Universities, 1800-1900*. Chicago: University of Chicago Press

Odling-Smee, F., Laland, K. and Feldman, M. (2003) *Niche Construction: A Neglected Process in Evolution.* Princeton: Princeton University Press

Paley, W. (2009) *Natural Theology: or, Evidences of the Existence and Attributes of the Deity, Collected from the Appearances of Nature.* Cambridge: Cambridge University Press

Pence, C. (2018) Sir John F. W. Herschel and Charles Darwin: Nineteenth-Century Science and Its Methodology. *The Journal of the International Society for the History of Philosophy of Science*, 8(1), pp.108-140

Pepper, J. and Herron, M. (2008) Does Biology Need an Organism Concept? *Biological Reviews* 83, pp. 621–627

Popper, K. (1980) *The Logic of Scientific Discovery*. Revised edition. London: Hutchinson

Pradeu, T. (2012) *The Limits of the Self: Immunology and Biological Identity*. Oxford: Oxford University Press

Pradeu, T. (2010) What is an Organism? An Immunological Answer. *History and Philosophy of the Life Sciences*, 32 (2-3), pp.247-267

Pradeu, T. (2013) Immunity and the emergence of individuality. In *From Groups to Individuals: evolution and emerging individuals*. Edited by Bouchard, F. and Huneman, P. Cambridge: The MIT press, pp.77-96

Pradeu, T. (2016) Organisms or biological individuals? Combining physiological and evolutionary individuality. *Biology & Philosophy*, 31 (6), pp.797-817

Prigogine, I. and Stengers, I. (1984) *Order out of Chaos: Man's New Dialogue with Nature*. New York: Bantham Books

Quarfood, M. (2004) *Transcendental Idealism and the Organism: Essays on Kant*. Stockholm: Almqvist and Wiksell International

Ratcliffe, M. (2001) A Kantian Stance on the Intentional Stance. *Biology and Philosophy*, 16, pp.29–52

Reichenbach, H. (1938) *Experience and Prediction*. Chicago: University of Chicago Press

Richards, R. (1997). Darwin and the inefficacy of artificial selection. *Studies in History and Philosophy of Science*, 28(1), pp.75–97.

Richards, R. (2002) *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe*. Chicago: University of Chicago Press

Richards, R. (2004) Michael Ruse's Design for Living. *Journal of the History of Biology*, 37(1), pp. 25-38

Richards, R. (2016a) Charles Darwin: Cosmopolitan Thinker. In Richards, R. and Ruse, M. *Debating Darwin*. Chicago: Chicago University Press, pp.83-150

Richards, R. (2016b) Response to Ruse. In Richards, R. and Ruse, M. *Debating Darwin*. Chicago: Chicago University Press, pp.151-176

Richman, K. (2000) Introduction. In *The New Hume Debate*. Edited by Read, R. and Richman, K. London: Routledge, pp.1-15

Roqué, A. (1985) Self-Organization: Kant's concept of teleology and Modern Chemistry. *The Review of Metaphysics*, 39(1), pp.107-135

Ruse, M. (1975) Darwin's debt to philosophy: An examination of the influence of the philosophical ideas of John F.W. Herschel and William Whewell on the development of Charles Darwin's theory of evolution. *Studies in History and Philosophy of Science*, 6(2), pp.159-181

Ruse, M. (1978) Darwin and Herschel. *Studies in History and Philosophy of Science.*, 9(4) (pp. 323-331)

Ruse, M. (2003) *Darwin and Design: Does Evolution have a Purpose?* Cambridge: Harvard University Press

Ruse, M. (2016a) Charles Darwin: Great Briton. In Richards, R. and Ruse, M. *Debating Darwin*. Chicago: Chicago University Press, pp.1-81

Ruse, M. (2016b) Reply to Richards. In Richards, R. and Ruse, M. *Debating Darwin*. Chicago: Chicago University Press, pp.177-202

Schrödinger, E. (1992) *What is Life? With Mind and Matter and Autobiographical Sketches.* Cambridge: Cambridge University Press

Smolin, L. (2006) *The Trouble with Physics: The Rise of String Theory, The Fall of a Science and What Comes Next*. London: Penguin Books

Snyder, L. (2006) *Reforming Philosophy: A Victorian Debate on Science and Society*. Chicago: University of Chicago Press

Sober, E. (2009) *Did Darwin Write the Origin Backwards?: Philosophical Essays on Darwin's Theory*. New York: Prometheus Books

Stern, R. (2007) Transcendental arguments: A plea for modesty. *Grazer Philosophische Studien* 74(1), pp.143-161

Strawson, G. (2008) David Hume: Powers and Objects. In *Real Materialism and Other Essays*. Oxford: Oxford University Press, pp.415-438

Strawson, G. (2014) *The Secret Connexion: Causation, Realism and David Hume.* Revised edition. Oxford: Oxford University Press

Strawson, P. (1966) *The Bounds of Sense: An Essay on Kant's Critique of Pure Reason.* London: Methuen and Co

Stroud, B. (1968) Transcendental Arguments. *The Journal of Philosophy.* 65(9), pp.241-256

Symons, J. (2010) The Individuality of Artifacts and Organisms. *History and Philosophy of the Life Sciences*, 32(2-3), pp.233-246

Tauber, A. (1991) Speculations Concerning the Origins of the Self. In *Organism and the Origins of the Self*. Edited by Tauber, A. Kluwer Academic Publishers: Dordrecht, pp.1-40

Tauber, A. (1994) *The Immune Self: Theory or Metaphor?* Cambridge: Cambridge University Press

Teufel, T. (2010) Wholes that cause their parts: Organic self-reproduction and the reality of biological teleology. *Studies in History and Philosophy of Biological and Biomedical Sciences*, 42, pp. 252–260

Thagard, P. (1977) Darwin and Whewell. *Studies in History and Philosophy of Science.* 8(4), pp.353-6

Turnbaugh et al., (2007) The human microbiome project: exploring the microbial part of ourselves in a changing world. *Nature*. 449(7164), pp. 804–810.

Turner, S. (2004) Extended Phenotypes and Extended Organisms. *Biology and Philosophy*, 19(3), pp.327–352

Turner, S. (2013) Superorganisms and Superindividuality: The Emergence of Individuality in a Social Insect Assemblage. In *From Groups to Individuals: evolution and emerging individuals*. Edited by Bouchard, F. and Huneman, P. Cambridge: The MIT press, pp.219-242

Van Nood E., Vrieze, A. et al. (2013) Duodenal infusion of donor feces for recurrent Clostridium difficile. *New England Journal of Medicine* 368(5), pp.407-415

Walsh, H. (1962) Whewell on Necessity. *Philosophy of Science*, 29(2), pp. 139-145
Walsh, W, H. (1967) Schematism. In *Kant: A Collection of Critical Essays*. Edited by Wolff, R. Anchor Books: New York, pp.71-87

Waters, K. (2003) The Arguments in the *Origin of Species*. In *The Cambridge Companion to Darwin.* Edited by Hodge, J. and Radick, G. Cambridge: Cambridge University Press, pp.116-139

Watkins, E. (2005) *Kant and the Metaphysics of Causality*. Cambridge: Cambridge University Press

Watkins, E. (2017) Kant on the Distinction between Sensibility and Understanding. In *Kant's Critique of Pure Reason: A Critical Guide*. Edited O'Shea, J. Cambridge: Cambridge University Press, pp.9-27

Weber, A. and Varela, F, J. (2002) Life After Kant: Natural Purposes and the Autopoietic Foundations of Biological Individuality. *Phenomenology and the Cognitive Sciences*, 1(2), pp.97-125

Weinstock, J. and V. Elliott, D, E. (2014) Helminth Infections Decrease Host Susceptibility to Immune-Mediated Diseases. *The Journal of Immunology*. 193, pp.3239–3247

Wilson, E, O. (1998) *Consilience: The Unity of Knowledge*. London: Little, Brown and Company

Wilson, E. O. (1975) *Sociobiology: The Abridged Edition*. Cambridge: Harvard University Press

Winkler, K. (2000) The New Hume. In *The New Hume Debate*. Edited by Read, R. and Richman, K. London: Routledge, pp. 52-87

Wood, A. (1984) Kant's Compatibilism. In *Self and Nature In Kant's Philosophy*. Edited by Wood, A. London: Cornell University Press, pp.73-101

Yeo, R. (1979) William Whewell, natural theology and the philosophy of Science in mid nineteenth century Britain. *Annals of Science*, 36(5), pp.493-516

Zammito, J. (2006) Teleology then and now: The question of Kant's relevance for contemporary controversies over function in biology. *Studies in History and Philosophy of Biological and Biomedical Sciences* 37(4), pp.748-770

Zammito, J. (2012) The Lenoir thesis revisited: Blumenbach and Kant. *Studies in History and Philosophy of Biological and Biomedical Sciences*, 43(1), pp.120-132

Zumbach, C. (1984) *The Transcendent Science: Kant's Conception of Biological Methodology*. The Hague: Martinus Nijoff Publishers