THE PROBLEM OF INDUCTION
FROM A METAPHYSICAL POINT OF VIEW

ESER BAKDUR

BOĞAZİÇİ UNIVERSITY

2013

THE PROBLEM OF INDUCTION
FROM A METAPHYSICAL POINT OF VIEW

Thesis submitted to the

Institute for Graduate Studies in the Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts
in
Philosophy

by

Eser Bakdur

Boğaziçi University

2013

The Problem of Induction from a Metaphysical Point Of View

The thesis of Eser Bakdur
has been approved by:

Prof. Dr. Berna Kılınç _____
(Thesis advisor)

Prof. Dr. Gürol Irzık _____

Assist. Prof. İrem Kurtsal Steen _____

June 2013

Thesis Abstract

Eser Bakdur, The Problem of Induction from a Metaphysical Point Of View

The aim of this study is to examine the metaphysical solutions recently proposed for the problem of induction, which we inherited from the Scottish empiricist philosopher David Hume. The problem of induction concerns its justification. One way to understand the problem is as follows: If there is some time-invariant regularity in nature, can we know (or have some degree of justification for believing) it from experience? This is a conditional question; because, if there is no regularity, then there is no problem. Also, one need not assume that there is full regularity in many regards. According to Hume, our opinions regarding the unobserved parts of nature, our beliefs based on inductive inference are not justified. He argues that it is impossible to justify placing even a small degree of trust in any of our predictions regarding the unobserved parts of nature. The power of Hume's problem lies in the strength of this argument.

Recently, we see that there is a significant effort to provide a metaphysical solution to the problem of induction. The most prominent roles in this effort are played by the defenders of the views nomic necessitarianism and dispositional essentialism. In this thesis, both nomic necessitarian and essentialist solutions to the problem of induction are examined and taken issue with. This aim is pursued along two main lines. The first line is to show that the nomic necessitarian solution is incomplete since it does not help us with the epistemic issue, that is, how we can know (or have some degree of justification for believing) that there are time-invariant regularities from experience. The second line is to show that dispositional essentialist solutions, despite being more sophisticated than the nomic necessitarian solution, are highly problematic. The result of this examination is that, as they stand, none of these approaches to the problem of induction can overcome inductive skepticism as they claim to.

Tez Özeti

Eser Bakdur, Metafiziksel Bir Bakış Açısından Tümevarım Problemi

Bu çalışmanın amacı, İskoçyalı deneyci filozof David Hume'dan miras aldığımız tümevarım problemine dair yakın dönemde önerilen metafiziksel çözümlerin incelenmesidir. Tümevarım problemi tümevarımın gerekçelendirilmesiyle ilgilidir. Problemi anlamanın bir yolu şu şekildedir: eğer doğada zamanla değişmeyen bir düzenlilik varsa, onu deneyimden çıkarabilir miyiz veya düzenliliğin olduğuna inanmak için bir derece gerekçemiz olabilir mi? Bu şartlı bir sorudur; çünkü, eğer düzenlilik yoksa tümevarım sorunu da yoktur. Ayrıca, pek çok açıdan da doğanın tamamen düzenli olduğunu düşünmemize de gerek yoktur. Hume, tümevarımsal çıkarıma dayanan vargıların, doğanın gözlemlenmeyen kısımlarına dair görüşlerimizin gerekçesinin olmadığını, dahası doğanın gözlemlenmeyen kısımlarına dair tahminlerimizin herhangi birine çok az bile olsa güvenmeyi gerekçelendirebilmenin imkânsız olduğunu öne sürer. Hume'un probleminin gücü de bu argümanında yatar.

Son dönemde, tümevarım problemine metafiziksel bir çözüm getirilebileceğine dair önemli bir çabanın olduğunu görüyoruz. Bu çabada en öne çıkan rolleri oynayanlar nomik zorunlulukçuluk ve eğilimsel özcülük görüşlerinin savunucularıdır. Bu tez çalışmasında, her iki görüşün de tümevarım problemine getirdiği çözümler incelenmekte ve çözümlerine karşı çıkılmaktadır. Bu amaç doğrultusunda iki temel yol izlenmektedir. İlk yol, nomik zorunlulukçu çözümün, bize doğadaki zamanla değişmeyen düzenlilikleri deneyimden nasıl çıkarabileceğimiz konusunda yardımcı olmadığı için tam olmadığının gösterilmesidir. İkinci yol, eğilimsel özcü çözümlerin, nomik zorunlulukçu çözüme göre daha ileri çözümler olmasına rağmen, oldukça problemli olduğunun gösterilmesidir. Bu incelemenin vardığı sonuç ise, bu halleriyle, bu yaklaşımların hiçbirinin iddia ettikleri gibi tümevarımsal şüpheciliğin üstesinden gelemediği yönündedir.

ACKNOWLEDGEMENTS

No thesis is solely the work of one person. I would like to take this opportunity to express my gratitude to my thesis supervisor, Prof. Berna Kılınç, whose expertise, understanding, and charm added considerably to my graduate experience. Throughout my thesis-writing period, she provided me encouragement, sound advice, support, and lots of brilliant ideas. I would also like to thank the other member of my committee, Dr. İrem Kurtsal Steen for the assistance she provided at all levels of my thesis. I am grateful to her for reading my thesis by paying attention to every detail, for her crucial contribution and for her invaluable company and support. I would also like to thank the other member of my committee, Prof. Gürol Irzık for his assistance and encouragement he provided me at different levels of my thesis. I am grateful to him for our conversations which helped me gain an insight into the issue. I also owe a special thanks to Prof. Mehmet Elgin who has been very kind to help me with his suggestions for the determination of my thesis subject in the earlier period.

Lastly, I would like to thank my parents for being so patient and supportive as well as encouraging; their unconditional love enabled me to complete this work. I am thankful to my close friend, Nil Göksel, for being so supportive and encouraging me. And I would also like to thank all my other friends who have been very supportive throughout my graduate experience.

To My Parents

CONTENTS

CHAPTER I: INTRODUCTION……... 1
CHAPTER II: THE PROBLEM OF INDUCTION
AND HUMEAN METAPHYSICS…….. 8
The Problem of Induction ……..... 8
Inductive Skepticism and Humean Metaphysics ……. 13
Inductive Skepticism and Inference to the Best Explanation.... 20
CHAPTER III: THE PROBLEM OF INDUCTION
AND NOMIC NECESSITARIANISM…….. …… 25
Armstrong's Theory of Laws and Induction …… 26
Critique of Armstrong's Intended Solution …….. 28
CHAPTER IV: THE PROBLEM OF INDUCTION
AND DISPOSITIONALISM ……. 34
Properties …… 34
Categoricalism vs. Dispositionalism ……. .. 41
The Dispositionalist Approach to the Problem of Induction..... 45
Ellis' Dispositional Essentialist Solution ……..... 46
Critique of Ellis's Intended Solution ……..... 51
Lowe's Dispositional Essentialist Solution ……..... 63
Critique of Lowe's Intended Solution ……..... 66
The Pandispositionalist Approach to the Problem of Induction 69
Suggestion for Further Study …… 77
CHAPTER V: CONCLUSION ……. 79
REFERENCES …….. 80

TABLES

1 Humean World …… 24
2 Humean vs. Armstrongian World ……..... 33
3 Types of Necessities …… 44
4 Humean, Armstrongian, Ellisian, Lowean
and Pandispositional World …… 75

CHAPTER I: INTRODUCTION

Induction is making an inference from observed matters of fact to unobserved matters of fact. We experience repeated matters of fact in nature. In our experience, electrons generate electromagnetic fields, water boils at 100°C at sea level, plants photosynthesize at nights, so on. While we infer, based on our repeated experiences that these occurrences hold universally, we happen to pass from the observed parts of nature to her unobserved parts. Similarly, when we infer that the next kettle of water we heat will boil at 100°C at sea level, or that this plant will photosynthesize tonight, etc., we are making an inference from the observed to the unobserved. The former is inductive generalization, the latter, projection – two forms of induction.

The use of inductive reasoning is considerably broad, from everyday life to science. We can use induction in our examinations concerning historical events or facts as well as contemporary events or facts. For instance, when we study vanished and vanishing languages of the world, the extinct and endangered species, the French Revolution in 1789 and the ongoing Occupy Movement in 2011 and 2012, we rely on inductive inferences. Briefly stated, inductive inferences apply not only to predictions of future events but also past facts and present occurrences beyond the range of direct observation.

There are different types of induction. One type of induction, called enumerative induction or universal inference, is inference from particular instances to a general law or principle. Experimental sciences mostly employ enumerative

generalization.[1] For the purposes of this thesis, I will take induction to be inference from the observed to the unobserved, including enumerative generalization and projection.

Induction or inductive reasoning is usually contrasted with another process of reasoning, deduction. A conclusion is drawn from a set of premises in the deductive reasoning process; indeed, it necessarily follows from the premises given. That is, deduction is truth-preserving. Yet, it is not ampliative since the premises already contain the content of the conclusion. Compared with deduction, induction, although being ampliative, is not necessarily truth-preserving. A correct inductive argument may have true premises and a false conclusion. Also, compared with deduction, induction is a process that has some limitations by its nature. For instance, the fact that induction can never arrive at certainty, that is, in other words, its fallibility, is its natural component. We may never be sure about whether the sun will rise tomorrow. So, we bear in mind that we are fallible in our inductive conclusions when we make an inference from observed matters of fact to unobserved matters of fact. Let us leave this aside for the moment.

There is a major problem about induction in the literature which we inherited from the great empiricist David Hume: 'the problem of induction', as we call it now. Basically, the main problem of induction concerns its justification. To put it briefly, not only we may never be certain about whether the sun will rise tomorrow but also we have no good reason for thinking that that the sun has risen in the past supports that it will rise tomorrow. This is because we have no good reason to accept the principle of uniformity of nature, i.e., the assumption that patterns of regularity that

[1] The other types of induction are simple induction, ampliative induction, argument from analogy, etc. but in this work I will not look at them individually.

are observed in the universe now have always been observed in the universe in the past, apply everywhere in the universe, and will continue to hold in the future. Far from being certain, we cannot even say that the possibility of realization of our expectations is high or that repeated experiences render the realization of our expectations more probable. Given this, even such modest cases seem far from being known.

One way to understand the problem of induction is as follows: if nature contains some time-invariant regularity, is it possible for us to know it (or have some degree of justification for believing it) from experience? This is a conditional question; because if there is no regularity, then there is no problem. Hume indeed was skeptical about the presence of such regularities in nature. Moreover, he remained agnostic about finding an answer to the question whether there are such regularities, uniformities, in nature. Ever since Hume drew our attention to it, the problem of induction became one of the classical problems of philosophy. Recently, we see that there is a significant effort to provide a metaphysical solution to it. The most prominent roles in this effort are played by the nomic necessitarian David M. Armstrong and the dispositional essentialists Brian Ellis, Howard Sankey and E. Jonathan Lowe.[2] These metaphysicians, except Lowe, aim to solve the problem whereas Lowe aims to dissolve the problem taking a dispositionalist stance towards nature's makeup.

Armstrong and the aforementioned dispositional essentialists try to overcome the problem of induction in two different ways. The first, and more prominent, way

[2] Firstly, as Vetter (2011) puts it, Ellis is a property essentialist (p. 749) whereas Lowe is object essentialist (p. 745). Since Sankey is sympathetic to Ellis's version of essentialism, Sankey is a property essentialist too. Secondly, Ellis and Sankey offer a solution to the problem of induction, and Lowe comes up with a dissolution indeed.

is by aiming to justify the existence of time-invariant regularities in nature. In case of nomic necessitarianism, time-invariant regularities amount to unchanging necessary connections (or rather real relations of necessity) holding between universals whereas in case of dispositional essentialism, in particular of scientific essentialism, time-invariant regularities amount to the certain behaviors of permanent natural kinds which have dispositional essences, viz. a set of uniquely clustered causal powers. Some of the time-invariant regularities in nature are laws of nature. Therefore, we can also say that nomic necessitarians and dispositional essentialists try to overcome the problem of induction by aiming to justify the existence of laws in nature.[3]

The second way nomic necessitarian and dispositionalist theories defend induction is by appealing to inference to the best explanation. In this form of reasoning, one draws/infers a conclusion that best explains a phenomenon. The idea is that when we have a best available argument for the existence of this phenomenon, we are licensed to believe in it simply on that account. Among those who defend induction by appealing to inference to the best explanation are Armstrong and Sankey. (This subject will show up in two places in the course of this work. Firstly it will appear at the end of chapter 2 when looking at Sankey's proposal, which is not based on metaphysics, and secondly at chapter 3 when discussing Armstrong's proposal.)

On the other hand, Lowe aims to defend induction by dissolving the problem of induction. In his opinion, nature is non-uniform and perhaps only the fundamental

[3] That is to say, nomic necessitarians and dispositional essentialists are realists about laws in nature. Yet, their conceptions of what it is to be a law of nature differ from each other as we will see.

physical laws in nature are strict laws, the rest are non-strict. All the laws are normative and dispositional in character and tell us only how things ought to tend to act. Inductive inferences are generic statements which express laws. He claims that we perhaps do not have knowledge about the behavior of things in nature, but inductive inferences are nonetheless informative about the way things are.

Both nomic necessitarianism and dispositional essentialism are in essence necessitarian views. The proponents of these views accept that there are necessary connections in nature. There is a huge contrast between necessitarianism and Humeanism, namely anti-necessitarianism. Humean metaphysic is based on the view that that there are no necessary connections in nature. To be more specific, necessitarians think that there is order in the universe *because* there are necessary connections between distinct events. Humeans, on the other hand, cannot give an explanation for the order in the universe; they take it as a brute, primitive fact. Therefore, it can be argued that what nomic necessitarianism or dispositional essentialism actually indicates to us is that the world constrains the proper metaphysical infrastructure to legitimize inductive inferences which Humeanism lacks.

To put it differently, *if* one adopts a worldview according to which there are time-invariant necessary connections (like Armstrong, for instance) or dispositional essences of permanent natural kinds (like Ellis, for instance) in nature, then one has a basis for believing that the unobserved will resemble the observed. Believing in no time-invariant regularities or laws of nature, however, leaves one without a basis for inductive inference. Or, so these philosophers claim.

In this thesis, I take issue with both nomic necessitarian and essentialist solutions to the problem of induction. The nomic necessitarian solution is incomplete since Armstrong does not help us with the epistemic issue, that is, how we can know or have some degree of justification for believing that there are time-invariant regularities from experience. The essentialist solution to the problem proposed by Ellis, despite being a more sophisticated one than the nomic necessitarian solution, is problematic. Lowe's proposal has problems too. Consequently, I will argue that, as they stand, none of these approaches to the problem of induction can overcome inductive skepticism as they claim to.

The body of this work is comprised of four chapters. I will begin with a chapter, introducing inductive skepticism. I will describe the problem of induction as Hume put it forward. To give a more complete picture, I will examine the characteristics of Humean metaphysics (also called the 'regularity view'), particularly its most sophisticated formulation achieved by David Lewis. Then, I will elaborate on why the Humean metaphysics encourages inductive skepticism. Lastly, I look at Sankey's account to see whether science can handle skepticism issue in itself.

Throughout Chapter 3, I will explain the nature's makeup according to nomic necessitarianism. After specifying the outlines of this view, I will focus on Armstrong's theory of the laws of nature and his solution to the problem of induction. Then, I will criticize his solution. My examination of Armstrong's arguments is intended to show us that the nomic necessitarian account of nature cannot overcome inductive skepticism.

In Chapter 4, I will move to dispositionalism which is opposed to both the regularity view and nomic necessitarianism, and will look at the dispositionalist approach to the problem of induction. I will begin with a section on properties with regard to nature's ontology. Firstly, I will explain the distinction between dispositional properties (dispositions, powers) and categorical properties and sketch out the basic positions about the nature of properties in the literature. To put it in a nutshell, categoricalism holds that the relation between a property's identity and its role is contingent. By contrast, this relation is necessary on dispositionalism.

After presenting the main concepts and the basic positions, I will present Ellis's essentialist solution to the problem of induction and give my own critique of account. My examination of Ellis's solution is intended to show us that it cannot overcome inductive skepticism. (The main reason why dispositional essentialism cannot overcome inductive skepticism is that since it is not possible to observe all the conditions in nature, it is also not possible to know how powers are disposed to act under all circumstances.) After Ellis, I will look at Lowe's proposal and argue that Lowe's account cannot dispense with the problem of induction either. Lastly, I will present the pandispositionalists' approach to the problem of induction. Pandispositionalists think that the problem of induction is a pseudo-problem. I think that the problem applies to pandispositionalism too. Consequently, in this thesis, as in the case of nomic necessitarianism, I will argue that dispositional essentialism cannot overcome inductive skepticism either. Lastly, I will end this chapter with a suggestion for those who might want to elaborate on the issue more in further studies.

CHAPTER II: THE PROBLEM OF INDUCTION AND HUMEN METAPHYSIC

The Problem of Induction

Hume laid the foundation of what is now called the problem of induction in Book I, Part III, section VI of the *Treatise.* In the Abstract of 1740, the argument concerning induction takes a much more prominent version[4], and the section 4 of the first Enquiry contains its most sophisticated form.[5] The problem of induction is essentially a problem about the logical foundation of inferences from observed matters of fact (parts of nature we observed) to unobserved matters of fact (that is, parts of nature we have not observed or lie beyond the range of our observation). More specifically, the problem is one that reveals the unjustifiability of inductive inferences. Discussions of the problem of induction concern not only predictions of future events but also extrapolation of inferences from past facts to the past occurrences beyond the range of direct observations of the time at issue (say, extrapolation of inferences about dinosaurs) and extrapolation of inferences from past facts to present occurrences beyond the range of direct observations (say, extrapolations of inferences about electrons or DNAs). So, what is 'the' problem of induction that Hume led the way for us to think over?

[4] In the *Abstract* of 1740 the argument is elevated to a much more prominent position, as the centre-piece of Hume's "Chief Argument".

[5] The fullest and clearest version is in the first *Enquiry*, Section 4.

What is ‘the’ Problem of Induction?

The problem of induction has two components. The first component concerns the way we think and reason. The second component concerns the legitimacy of the way we think and reason. Let us begin with the first component. According to Hume, we generate our opinions about the things we have not observed in two ways. This brings us to his well-known distinction between propositions that concern *matters of fact* and propositions that concern *relations of ideas*.

Relations of ideas are propositions regarding our concepts or ideas. In more modern terms, they are analytic propositions. We get to know these propositions by thinking over them. To be more precise, if we think of their denial and see that their denial amounts to a contradiction, it means that the original proposition has to be true. For instance, take the proposition that all bachelors are unmarried. We know this proposition because we can realize that a married bachelor is a self-contradiction. Hence, such propositions are knowable a priori. They do not tell us anything about the actual world, contrary to propositions concerning matters of fact.

Matters of fact are propositions that convey information about the way things actually are in the world. In modern terms, matters of fact are synthetic propositions. They are things that we cannot know to be true or false just by resorting to our ideas or by thinking about our ideas. Let us consider, for instance, the proposition “Istanbul is a bi-continental city” or the proposition that “the sun will rise tomorrow”. Neither the concept of Istanbul nor the concepts of bi-continentality and city; or neither the concept of sun nor the concepts of rising and time are logically connected with each other; indeed Istanbul could have been a city that was not bi-

continental (at one time it was not a bi-continental city, indeed) or the sun could not rise tomorrow. Matters of fact are not knowable a priori.

According to Hume, we obtain our knowledge of matters of fact from experience. For instance, in our experience the appearance of sun has been regularly associated with a sensation of warm/hot. In other words, we have perceived that in our experience so far, the sun has always been warm/hot. On this basis, we conclude that sun is always warm/hot in general or at least the next appearance of sun that we will examine will be warm/hot. That is to say, we obtain our knowledge of unobserved matters of facts from experience as well, and by inference from observed matters of fact, following a general pattern, namely induction. When we claim to know something by induction, the thing we claim to know is of the 'matters of fact' category, not 'relations of ideas' category. The conclusions we draw from experience can be denied, they are never opposed to contradictions. For instance, even though we see that there is sun outside the window, the weather might be not warm/hot. Therefore, the knowledge of matters of fact needs to be obtained from experience.

According to Hume, our reasoning concerning the matters of fact is based on causation, the relation of cause and effect. And the foundation of our conclusions concerning causal relations is experience. Hence, our knowledge of matters of fact is obtained through a process of cause and effect in our experiences. Without experience, we cannot make any predictions about what will cause what. Given experience as the only guide, in order to make any prediction about future, we have to have some basis for extrapolation from our experience to the future. This basis is the assumption of uniformity of nature (the past will resemble the future, in that when sufficiently similar situations recur, similar effects follow – that is, the course

of nature continues uniformly the same): what has happened in the past is the guide to (infer or predict) what will happen in the future. That is to say, when we make inductive inferences, we employ uniformity of nature as if it is a guarantee principle that tells us what has happened in the past and present supports what will happen in future.

What justifies our belief in the uniformity of nature, then? We hold the belief of uniformity of nature simply because we have an experience of uniformity in the past (or at least we think we had). Hence, at this point when we make a further inference that nature will maintain its uniform character in the future, it means that we are making an inference from the observed to the unobserved again - namely, we are establishing the truth of the uniformity of nature principle inductively. Therefore, in the end, it turns out that the justification is a circular one. That is, we have no non-circular ground for the assumption of uniformity of nature.

Resorting to causality in the justification of our belief in inductive inferences ends up in a circular argument too. Hume thinks that even if we have experienced constant conjunction (i.e., the unvarying succession of paired events) of causes and effects, it is just a matter of psychological expectation that a particular event (that is, a cause) will be followed by another event (that is, an effect) and invariably associated with it. Expectations are feelings that are generated by regularities of experience. The idea of necessary connections is produced by these feelings. And in Hume's opinion, it is an untestable hypothesis that there is an objective physical necessity with which this idea matches. Thus, he maintains his skeptical position about causal necessity.

So, what happens is the following: we observe an event of one type (e.g., doing exercise) occurring prior to and contiguously with an event of another type (e.g., sweating) and we realize that events of the two types have exhibited a constant conjunction up to present. Yet we cannot discover any necessary connection between them a posteriori. When we infer based on our past experiences that this constant conjunction will continue to hold in future cases, we are making another inference from observed to unobserved cases. And if we attempt to justify our belief in inductive inference resorting to causality as a basis, this turns out to be a circular one again -- for we are making inferences from the observed to the unobserved again and again while leaning on the principle of uniformity of nature. Hume's solution is that we are psychologically disposed to exercise inductive reasoning and hence make inductive inferences. We maintain and will maintain exercising inductive reasoning. Yet there is no way to justify inductive behavior on rational grounds.

In Hume's philosophy, the problem of induction primarily arises from the lack of necessary connections between distinct events, in other words, cause and effect properties. The experience of constant conjunction is merely a habit of the mind, the world does not contain causal necessity as an objective part of it, that is, there is no objective ground for inductive inference.

Why should we care about the problem of induction? In science and in ordinary life the use of inductive reasoning is prevalent. We hold many beliefs that are derived by inductive reasoning and we will continue to employ inductive reasoning to form opinions, make sense of the world, deal with scientific or daily problems we encounter, etc., in short, to acquire knowledge. If no such inferences are rationally justified, it looks like we should give up much of what we now believe.

Some metaphysicians argue for the possibility of a metaphysical solution to inductive skepticism. The problem of induction is a question in epistemology; therefore, it is expected that a solution to the problem must ultimately be an epistemological one. Why, then, should we pay attention to a metaphysical solution in the first place or at all? If what we are looking for is whether there is any good inductive strategy, we would better take nature's makeup into consideration because how we think about nature's makeup determines how we would reason about her. And eventually this affects the epistemic task with which we engage. In addition to this, perhaps only a metaphysical or rather a necessitarian's perspective sets the skeptic's mind at ease about something in nature making things happen regularly. Hence it seems that, for a metaphysician, these give substance to the idea that there can be a metaphysical solution to the problem of induction.

So, to evaluate whether a metaphysical solution is possible, we firstly need to look at how nature's makeup is conceived from different metaphysical stances. These views are the Regularity View (Humean metaphysics), Nomic Necessitarianism (the Metaphysics of Universals) and Dispositionalism (Metaphysics of Powers).[6] So, let us begin with Humean metaphysic and its relation with inductive skepticism.

Inductive Skepticism and Humean Metaphysics

The Humean metaphysic is a metaphysic founded upon the rejection of necessary connections between distinct entities in the world. The world exhibits regularities in

[6] Today in philosophy of science, these positions take place in the project called 'Metaphysics of Science'. This project aims to analyze the role of metaphysics in scientific theorizing. It covers the abstract examination of ontological issues, issues about law, cause, natural kind, disposition, so on, as they occur in the sciences and their findings, concepts, models, theories etc.

the distribution of the fundamental properties and the causal powers of objects stem from these regularities. It is possible that, say, property P is regularly followed by, say, property Q; however, nothing brings about this regularity or any other regularity in the Humean kind of world. This is just the way things are in the world, simply a brute fact.

Humean metaphysic achieves its most sophisticated formulation in David Lewis's thesis of Humean supervenience. Lewis (1986) says,

> It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another. (…) We have geometry: a system of external relations of spatio-temporal distance between points. Maybe points of spacetime itself, maybe point-sized bits of matter or aether or fields, maybe both. And at those points we have local qualities: perfectly natural intrinsic properties which need nothing bigger than a point at which to be instantiated. For short: we have an arrangement of qualities. And that is all. There is no difference without difference in the arrangement of qualities. All else supervenes on that. (p. ix-x)

According to Lewis's formulation, the whole world is made up of perfectly natural, local, unconnected property instances and spatio-temporal relations among them. Local, particular property instances are primitively distributed over the whole of space-time and everything else ~ modal, causal and nomic facts ~ supervenes on this primitive spatio-temporal distribution of these property instances. Moreover, the spatial arrangement of these fundamental physical properties in the world is contingent. That is to say, it is quite possible to have had an entirely different spatial arrangement of the same fundamental physical properties in this world, or to have different properties altogether.

If one wonders the reason for the present unfolding of the distribution of fundamental physical properties in the universe or for the order in the world, then one finds no reason in the Humean metaphysic; causation or laws cannot count as a

reason[7] since they contingently supervene on that distribution (Esfeld, 2010). The fact that causation and laws contingently supervene on the primitive, wholesome base indicates to us that causation and laws are not among ontologically basic parts of the fundamental fabric of the universe.[8]

In a Humean world, there are no necessary connections between distinct properties qua entities. It is the case that one thing happens, and then another thing happens, and then another, and so on but there are no internally or externally necessary connections between them. Each happening is self-contained. Still, there can be seen constant conjunctions of events in a Humean world. For instance, we can discover that there is always a property q next to a property p in the world. Yet the fact that a property instantiates at some space-time point entails nothing about any other space-time points (Beebee, 2006). So, constant conjunctions should not confuse us as to the existence of necessary connections in the world. An objective history or regular pattern of events in the world may pave the way for us to construct beliefs about necessity but Hume has explained to us that nothing about the fact of constant conjunction requires such necessity nature -- necessity is merely in our minds.

[7] Some may disagree with Esfeld and can claim that perhaps laws counts as a reason on Lewis's understanding of an explanation - an economic, elegant summary of everything. Even so, laws are not ontologically basic parts of the fundamental fabric of the universe.

[8] In *Laws in Nature*, Mumford (2004) claims that the scientific and metaphysical approaches to laws are different from each other. Science concerns itself with both observable and unobservable phenomena and the empirical facts. Metaphysics is interested in more, for instance in the question like what it is to be law of nature. He argues that a Humean kind of world is a lawless world in the sense that laws are not real, existent things in nature responsible for the change in the world. In the metaphysical sense, what makes a law of nature real is to have a separate ontological status in the world's inventory and to make things happen or, to put it simply, govern them.

Humean Metaphysics and Categoricalism

Given the absence of necessary connections between distinct entities, it follows that properties of things and their causal powers are only contingently related in a Humean world – to be more accurate, categoricalism follows. Categoricalism is one of the two positions about the essences of natural properties (the other being dispositionalism, to which we turn in Chapter 4). On categoricalism, the relation between all the fundamental physical properties in the universe and the behavior of objects that have these properties is not a necessary relation (in other words, the relation is contingent). That is why a particular thing might have the causal power C due to having the property P in this world while it might have the property P without having the causal power C in other possible worlds. (If it were dispositionalism that one holds with respect to the essences of properties, then this relation would not be contingent. That particular thing would have the property P with the causal power C in all possible worlds.)

Spatio-temporally distributed properties are embedded in various sorts of regularity in a Humean world. Hence, the neo-Humean metaphysic provides a basis for the regularity view of laws, which says that there are only regularities in the world, definite of these are the laws of nature, and metaphysically real connections play no part in bringing them about. Lewis appeals to the 'best system' analysis (also known as the 'Ramsey-Lewis view') to differentiate regularities that are laws from regularities that are not laws. The best-system analysis indicates that the laws of nature are those regularities that "buy into those systems of truths that achieve an unexcelled combination of simplicity and strength" (1986, p. xi) (to be simple is to specify everything in a concise way; to be strong is to bear a great deal of informational content), where the candidate regularities "seem to supervene safely on

the arrangement of" fundamental physical properties (ibid). [9] Therefore, in a Humean world, laws of nature supervene on this spatial arrangement of fundamental physical properties.

Humean Metaphysic Encourages Inductive Skepticism

As concerns the relationship between Humean metaphysic, categoricalism and the problem of induction, we can say that Humean metaphysic encourages inductive skepticism. According to Ellis's formulation (2002), Humean metaphysics portrays a world that is kind of an inactive mechanism, in which

> (a) inanimate matter is essentially passive, never intrinsically active;
> (b) things behave as they are required to by the laws of nature;
> (c) the dispositional properties of things (including their causal powers) are not real properties, and are never intrinsic to the things that have them;
> (d) the essential properties of things never include any dispositional ones;
> (e) causal relations are always between logically independent events;
> (f) the laws of nature are universal regularities imposed on things whose identities are independent of the laws; and
> (g) the laws of nature are contingent, not necessary. (pp. 59-60)

These characteristics of the Humean world render the relations between things and their behavior entirely contingent. If so, Humean metaphysics cannot provide a solution to the problem of induction for the following reasons: Since properties of inanimate matter are considered as categorical properties by Humeans, this renders inanimate matter essentially passive. Given this, they are not qualified to have an

[9] Also Lewis (1994) in his article "Humean Supervenience Debugged" states the view as follows:

> Take all deductive systems whose theorems are true. Some are simpler, better systematized than others. Some are stronger, more informative than others. These virtues compete: An uninformative system can be very simple, an unsystematized compendium of miscellaneous information can be very informative. The best system is one that strikes as good a balance as truth will allow between simplicity and strength. How good a balance that is will depend on how kind nature is. A regularity is a law iff it is a theorem of the best system. (p.181)

impact upon each other by means of internal connections. Hence, given the absence of internal connections between properties, events in a Humean world are disconnected, independent events. They just happen and happen randomly. That is to say, all the events in the past could have happened differently and there are also no strong constraints on the forthcoming events.

The passivism and hence the independence and the disconnectedness of the properties of the events lead us to the problem of induction. To illustrate this point, let us consider electrons. An electron, a subatomic particle with a negative electric charge found in all atoms, is involved in gravitational, electromagnetic and weak interactions. If we understand the nature of electrons as essentially passive, then we take their behaviors as being entailed by the contingent laws of nature, viz. by regularities. Laws are not separate entities that make things happen within Humean ontology.[10] According to a Humean, an electron's generation of an electric or a magnetic field is therefore an event that would just happen – yet happen regularly. However, any event in a Humean world is an event in which properties are causally non-influential on each other. Given that laws of nature do not have a place as a separate ontological category within the Humean metaphysic, we cannot count on laws of nature as the activators of the passive properties in events.

If it is the case, namely if nature lacks activators and regularities lack necessity and inner connection, then how can we make good inductive inferences about the behavior of passive entities (in this case, electrons), lean on the justification of the ones we think we made and project them to nature's unobserved parts? It seems that nothing hinders objects from acting irregularly or in radically different

[10] See Mumford (2004) for an insightful analysis.

ways in a Humean kind of world. One can say that inductive inferences about the behaviors of objects in the interactions they participate are made by grounding them on the assumption that nature is uniform. Yet at this point we should ponder on what grounds we assume that nature is uniform in a Humean world. We think that there is uniformity in nature but we do not provide a (non-psychological) answer to the question why we think there is uniformity in nature within the Humean framework. In other words, the Humean account contains no reason why the next instance should be like the former instances. Hence, metaphysically speaking, our inductive inferences remain groundless in the absence of necessities borne out of nature. Therefore, it seems that there is nothing in the past behavior pattern that could make true the prediction that the future behavior pattern will be similar to the past one.

These bring us to the vulnerability of the Humean metaphysics to the challenge posed by the problem of induction. This metaphysic is one that does not involve any modal features. The order in the world is merely a brute, unaccountable fact. Therefore, it would not be wrong to say that it is almost impossible to solve the problem of induction by adopting the Humean metaphysic since nothing in it rules out the possibility of a regularity breakdown at some point in the future. Regularities we have observed so far cannot make true the belief that regularities in the unobserved parts of nature are like the ones in her observed parts or that future regularities will be like the past ones. So, Humean metaphysic lacks the required metaphysical infrastructure to establish our epistemological task with which we could overcome inductive skepticism. Therefore, it would not be wrong to claim that Humean metaphysic encourages inductive skepticism (Ellis, 2001, 2002; Mumford, 2004).

Would it be possible to overcome the problem of induction without getting into a metaphysical solution? Could science handle the issue in itself, for instance? In this section, before looking at the offered metaphysical solutions, I want to look at a solution proposed by Sankey (1997) which does not get into metaphysics and to show why it is not helpful.

Sankey addresses the problem of induction, specifically the circularity problem of justifying induction by induction, by appealing to the inference to the best explanation. To be more precise, the way he appeals to the uniformity of nature invokes inference to the best explanation. He thinks that the world has a basic natural kind structure in the sense that the fundamental kinds of things that exist in nature belong to natural kinds. And he claims that the circularity aspect of the problem of induction is avoided when uniformity is interpreted via propositions about these natural kinds in the world. To construct the thesis that induction is justified in a non-circular way, he melts scientific realism[11], scientific essentialism and epistemic naturalism[12] into the same pot. The scientific essentialism extension of his account is based on Ellis's overall metaphysical stance, which we will examine in the fourth chapter. The epistemic naturalism extension of his account is based on Hilary Kornblith's views of the success of inductive inference presented in his book *Inductive Inference and its Natural Ground*. Kornblith (1993) claims that

[11] See Chakravartty, A. Scientific Realism. (Summer, 2011). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/sum2011/entries/scientific-realism

[12] For detailed information about epistemic naturalism, see Feldman, R. Naturalized Epistemology. (Summer, 2012). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/sum2012/entries/epistemology-naturalized

> Inductive inferences can only work, short of divine intervention, if there is something in nature binding together the properties which we use to identify kinds. Our inductive inferences in science have worked remarkably well, and, moreover, we have succeeded in identifying the ways in which the observable properties which draw kinds to our attention are bound together in nature. In light of these successes, we can hardly go on to doubt the existence of the very kinds which serve to explain how such successes were even possible. (pp. 41-42)

He, says Sankey (1997),

> [a]rgues that the best explanation of the success of scientific induction is the existence of natural kinds, which possess homeostatic property clusters, the co-occurrence of which assures the reliability of induction. This argument takes the success of induction as a given fact, and seeks to provide an explanation for this success. (p. 244)

Kornblith's argument represents an example of inference to the best explanation argument. Yet, Sankey criticizes Kornblith simply because he thinks that his argument did not deal with inductive skepticism. Despite this, he stays the course with Kornblith's epistemic naturalism yet presents us another argument that addresses inductive skepticism. Differently from Kornblith, he aims to defend induction on the grounds that nature is uniform in the following sense: "[i]t contains natural kinds, all of whose members possess a common set of essential properties" (p. 244). Yet he is aware of that defending induction as such is vulnerable to the circularity challenge because the essentialist claim is based on an inference to the best explanation, which is seen as a form of inductive inference (objection one, pp. 244). To show that his argument is non-circular, he (1997), in answering this objection, compares the following argument (a case of induction by enumeration)

> All observed A's have been B's.
> Therefore all A's are B's. (p. 245)

with the following argument

Science is successful.
The existence of natural kinds is the best explanation of the success of science.

Therefore, there are natural kinds. (ibid)

And he claims that no circularity is involved in the latter argument because the justification is based on an inference to the best explanation.

I think that Sankey's argument has problems. Firstly, the first premise 'science is successful' is itself a result of long-term practices; thus, it may contain some presuppositions that are formed inductively. So may the second premise 'the existence of natural kinds is the best explanation of the success of science'. Therefore, justifying induction by appealing to natural kinds might be employing induction in a deeper sense.

Secondly, the premise "science is successful" can trigger some debate. If the justification of natural kinds depends upon the success of science, as it is on Sankey's account, this may lead us to think that the method of science used to be somehow unjustified at the times science was not as successful as it is now.

Thirdly, what justifies the existence of natural kinds as the best explanation of the success of science? Given that scientific claims are fallible, as science progresses (namely, as new evidence becomes available), the claim that the existence of natural kinds is the best explanation of the success of science may turn out to be false. For instance, perhaps science would disprove the existence of all the putative natural kinds. As a matter of fact, today scientific disciplines such as biological, medical and social sciences, approach to the existence of kinds in a skeptical way because the changeability of the individuals poses problems in terms of determining the criteria for kind membership (Bird and Tobin, Winter 2012).[13] Therefore, the second premise of the argument should be revised in the following way: The existence of natural

[13] Bird, A. & Tobin, E. Natural Kinds. (Winter 2012). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/win2012/entries/natural-kinds

kinds is the current best explanation of the success of science. Consequently, I think that Sankey's argument has not overcome inductive skepticism yet.

To sum up, appealing to inference to the best explanation is one of the ways to deal with the problem of induction. I briefly examined how Sankey approached the subject matter; yet, since a more robust study of inference to the best explanation is outside the scope of this thesis, I will leave its further examination to a later study and move on to the nomic necessitarian approach to the problem of induction.

Hence, we have arrived at the end of Chapter 2. Let me summarize the ideas of this chapter in the form of a table (Table 1): In a Humean kind of world, the objects are passive and have no essences; the fundamental properties are categorical[14], modally and causally impotent and have quiddities;[15] quidditism entails categoricalism;[16] the relation between cause and effect property is constant conjunction; the laws of nature are regularities; the status of laws is reductionist; inductive inferences cannot be justified (according to Hume); and I argued that given the lack of necessity in nature, nothing hinders objects from acting irregularly or in radically different ways, and therefore the Humean metaphysic encourages inductive skepticism.

[14] The concept of categorical property will be explained in more detail in the sub-section 'Categorical Properties' of the section 'Properties' in Chapter IV.

[15] This will be explained in the sub-section 'Categoricalism' of the section 'Categoricalism vs. Dispositionalism' in Chapter IV.

[16] This will be explained in the sub-section 'Categoricalism' of the section 'Categoricalism vs. Dispositionalism' in Chapter IV as well.

Table 1 – Humean World

Objects	Passive
Essence	No Essence/ Heacceity
Properties Quidditism: the independence of property's identity and the nomic/causal roles it play.	Categorical/Modally, causally impotent Categoricalism entails quidditism
Causation: what is the relation between cause and effect property?	Constant Conjunction
Laws of Nature & Status of Laws	Regularities Reductionist
Is Induction Justified?	Hume argues that inductive inferences cannot be justified.
My view/critique.	Humean account of nature encourages inductive skepticism. Nothing hinders objects from acting irregularly or in radically different ways in Humean metaphysic. Regularities may break down at any point in future.

CHAPTER III: THE PROBLEM OF INDUCTION AND NOMIC NECESSITARIANISM

In the previous chapter, we have seen that the Humean account of nature is based upon the thesis that there are no necessary connections between distinct events. If we add necessity into this account of nature, we get nomic necessitarianism. A Humean, as we have said, thinks that nothing binds the world together but regularities arise from it. On nomic necessitarianism, however, it is not the regularities but something else that binds the world together. That something is the nomic necessitation relation, which is itself a genuine universal that holds contingently between distinct properties (also universals). Particular matters of fact do not simply happen to be distributed in the way they are, rather they are structured that way by this necessitation relation. And the causal powers of objects stem from their properties (universals) which are related to other properties (universals) by the necessitation relation.

Similar to Humean metaphysic, the properties are categorical properties on nomic necessitarianism as well. In other words, there is no necessary connection between two separate properties that stem from the properties themselves. That is to say, a nomic necessitarian's world is one whose fundamental physical properties are inactive or rather causally impotent but one that is nevertheless dynamic due to the laws of nature that govern these properties.

Nomic necessitarianism is defended by Armstrong (1983, 1997) and Tooley (1987) among others. [17] In *What is a Law of Nature*, Armstrong (1983) develops a theory which is essentially about laws of nature and argues that this theory paves the way for overcoming inductive skepticism (p. 104). He thinks that our world is a world of laws and laws are the reasons why there are regular patterns in the world. I will begin by briefly presenting the basics of his theory of laws, then continue with his argument about induction, and lastly argue that his argument cannot avoid the inductive skeptic's worry.

Armstrong's Theory of Laws and Induction

Armstrong's theory of laws offers a unified account of the relationships between laws, universals and causation. He admits real universals in addition to particulars within nature's ontology and describes the laws of nature as relations between universals. One universal (say, F) is related to another universal (say, G) through a certain relation, viz., a contingent necessitation relation (N), and he specifies that "this state of affairs may be symbolized as '$N(F,G)$'" (p. 85). To be more precise, what necessitates what is a contingent matter, although if the law N(F, G) holds, then given F, G is necessary. That is to say, F-ness necessitates G-ness. In other words, it is guaranteed by N that an instance of F is always followed by an instance of G. This framework allows him to add the existence of necessary connections between distinct entities which was missing in Humean metaphysic and arguing that laws of nature

[17] Armstrong takes properties qua universals as Aristotelian in the sense that they are present in the particulars that instantiate them. For Tooley, however, properties are Platonic entities.

play a special explanatory role in inductive inferences (Armstrong, 1991).[18] We should add that, although F and G are so linked, that N(F,G) holds contingently in Armstrong's ontology.

Armstrong's argument goes as follows. If inductive inference is conceived as a direct inference from 'all observed *F*s have been *G*s' to 'all *F*s are *G*s', then it is impossible to justify it. However, he thinks, an inductive inference is a two-stage inference. The first stage is the inference to the best explanation. He (1983) says,

> The inference to a connection of universals is a case of an inference to the best explanation. A series of states of affairs is observed, each a case of an F being a G. No Fs which are not Gs are observed. The postulation of the single state of affairs, the laws (F, G), gives a unified account of what is otherwise a mere series (p. 104).

That is, from the observed phenomena we infer the law via inference to the best explanation. Then, the first stage implies the second stage. He says, "[i]t deductively yields a prediction which enables it to be tested, the prediction that all other Fs will be Gs" (ibid). That is, the law entails that all the unobserved Fs are Gs. Hence, we reach the conclusion about the unobserved from the premise about the observed regularity through first and second stages. And he (1983) adds,

> [i]f this is correct, then induction becomes a particular case of the inference to explanatory ('theoretical') entities. The law … is a theoretical entity, postulation of which explains the observed phenomena and predicts further observations (ibid).

Thus, reminding us Hume's doubt on the rationality of inductive reasoning, he argues that induction is at least rationally explained for inference to the best explanation is a rational process. To cast Armstrong's argument,

[18] Dretske (1977), another nomic necessitarian, had a similar opinion.

All Observed Fs are Gs
Hypothesis: N (F, G) via IBE

Therefore, All Fs are Gs

Put together, Armstrong (1983) claims, while the regularity conception of laws makes way for inductive skepticism (p.52), the Universalist conception of laws help us defend induction (pp. 103). Consequently, he aims to justify the presence of time-invariant regularities in nature by virtue of laws of nature, to justify induction by appealing to inference to the best explanation.

Critique of Armstrong's intended solution

One way to approach Armstrong's solution can be the following: Armstrong does not help us with the epistemic issue – namely, how we can know these regularities (or have some degree of justification for believing them) from experience. One of the basic problems concerns the discovery of a specific universal, let us call this *the problem of discovery*: how can we know that there is a universal F? The problem of universals, one of the oldest philosophical problems inherited from ancient metaphysics, concerns the ontological status of these terms. That is, it is about whether universals exist or not. Therefore, given that there is the problem of universals, this would affect Armstrong's theory of laws of nature as well. If universals do not exist, then Armstrong's theory would collapse because all laws are interactions between universals. And hence, his proposal for the problem of induction would collapse as well.

The second basic problem is *the problem of classification of phenomena*, which is as follows: for any given object or phenomenon, how can we know which

universal it instantiates, essentially? For instance, suppose that there is a particular 'a', which attracts positively charged things. From its behavior, we infer that 'a' is negatively charged, and call being negatively charged F. But, what if 'a' is not F? It could be something else. Therefore, how do we know which universal it instantiates?

The third basic problem is the following: Can we know that there is a necessary connection, N? Suppose that it is observed that the property F is regularly followed by the property G (F and G co-occur). The existence of this regularity on Armstrong's account is explained or rather best explained by the existence of a necessary connection; so, it is thought that the property F is necessarily connected to the property G.[19] Yet, there is an issue here that needs to be taken into consideration: the particular regularity in question has been observed up to now only. In other words, we do not know whether it holds by nomic necessity. How exactly does inference to the best explanation ensure that this regularity, and of course any particular regularity, holds forever? (After all, the laws of nature hold contingently in an Armstrongian world.) Thus, it seems to me that inference to the best explanation concerns the regularities observed up to now only. Nonetheless, Armstrong concludes that the unobserved parts of nature would be like her observed parts by virtue of the necessary connections/laws. Therefore, it seems, while Armstrong is passing from the so-far observed regularities to the time-invariant regularities, he presupposes that nature is uniform. In other words, inference to the best explanation seems to ensure that particular regularities hold forever, if it does of course, only after one presupposes the principle of the uniformity of nature. This presupposition here seems to indicate to us that there is an inductive inference made in order to pass

[19] Armstrong claims that the passage from the existence of some regularly observed phenomena to the existence of there being a necessary connection/a law between them is a case of inference to the best explanation.

from the so-far observed regularities to time-invariant regularities (both observed and unobserved). That is to say, Armstrong seems to use induction in a deeper sense to justify induction. To further pursue this issue would require that we study the nature of inference to the best explanation in great detail which is beyond the scope of this work.[20] Therefore, I leave the examination of this issue to another study.

As a matter of fact, that the observed patterns will change at some point in future is something we find that Armstrong admits. He (1983) accepts the possibility of "spatio-temporally limited laws ('laws of cosmic epochs' or 'laws restricted to cosmic epochs') (pp. 100-101).[21] That is to say, different laws can hold to govern the universe in different periods of time. If spatio-temporally limited laws are possible, it means that some necessary connections can in principle cease to hold after time t, say tomorrow or distant future. This contradicts the notion of necessity because necessity is supposed to be time-limitless. Armstrong's allowance for laws restricted to cosmic epochs eventually weakens his argument. This is a fourth problem with his solution.

Even if we suppose for a moment that Armstrong is successful at his aim - that is, he has properly justified that there are time-invariant regularities in nature, his allowance for the possibility of spatio-temporally limited laws in nature's ontology complicates things even more. Let me explain *the temporality problem*, as I will call it, that the existence of the spatio-temporally limited laws creates.

Suppose that we grant the existence of "spatio-temporally limited laws" or the possibility of cosmic epochs in nature in addition to spatio-temporally unlimited

[20] To further pursue this issue, see Lipton, P. (1991). *Inference to the Best Explanation.* London: Routlegde.

[21] Armstrong (1987) argues that the problem of cosmic epochs is a problem for the regularity theory and claims that necessitarian theory can deal with it by modifying the relations between universals theory in some degree. See p. 24- 26 for spatio-temporally limited laws, and p. 100-101 for the discussion.

laws. Allowing the existence of both types of laws into nature's ontology poses an identification problem: how would we discern a spatio-temporally limited law and distinguish it from a spatio-temporally unlimited law, or vice versa, based on experience? How would we know which N(F,G) states of affairs hold time-invariantly and which don't? Therefore, Armstrong's assumption about cosmic epochs confronts him with a further problem that he needs to face.

Consequently, it seems that these points indicate to us that even though nomic necessitarianism makes the case better than Humean metaphysics towards a solution to the problem of induction, it has not dispensed with the problem yet. To deal with the problem of induction, nomic necessitarians need to revise their account.

Hence, we have arrived at the end of Chapter 3. As before, let me lay out the ideas of this chapter in the form of a table (Table 2): In a Armstrongian kind of world, the objects are passive and have no essences; the fundamental properties are categorical[22], modally and causally impotent and have quiddities[23]; quidditism entails categoricalism[24]; the relation between cause and effect property is contingent nomic necessity; the laws of nature are contingent relations holding between universals; the status of laws is primitive and immanent in the world; inductive inferences can be justified according to Armstrong; and I argued that Armstrong does not help us with the epistemic issue, that is, how we know time-invariant regularities from experience, and since he allows for the possibility of cosmic epochs, objects may

[22] The concept of categorical property will be explained in more detail in the sub-section 'Categorical Properties' of the section 'Properties' in Chapter IV.

[23] This will be explained in the sub-section 'Categoricalism' of the section 'Categoricalism vs. Dispositionalism' in Chapter IV.

[24] This will be explained in the sub-section 'Categoricalism' of the section 'Categoricalism vs. Dispositionalism' in Chapter IV as well.

begin to act irregularly or in radically different ways; and hence regularity may break down at any point in future.

Table 2 – Humean World and Armstrongian World

World	Humean World	Armstrongian World
Objects	Passive	Passive
Essence	No Essence/ Heacceity	No Essence/ Quiddity
Properties	Categorical, Modally/causally impotent	Categorical, Modally/causally impotent
Quidditism: the independence of property's identity and the nomic/causal	Categoricalism entails quidditism	Categoricalism entails quidditism
Causation: what is the relation between cause and effect property?	Constant Conjunction	Contingent nomic necessity
Laws of Nature & Status of Laws	Regularities. Reductionist.	Contingent relations between universals. Primitive, immanent in the world
Is Induction Justified?	Hume argues that inductive inferences cannot be justified.	Armstrong thinks that induction is rational, justifiable.
My view/critique	Humean account of nature encourages inductive skepticism. Nothing hinders objects from acting irregularly or in radically different ways in Humean metaphysic. Regularities may break down at any point in future.	Nomic necessitarian account of nature cannot help us overcome inductive skepticism. Armstrong doesn't help us with the epistemic issue, that is, how we know time-invariant regularities from experience.

CHAPTER IV: THE PROBLEM OF INDUCTION AND DISPOSITIONALISM

As opposed to nomic necessitarianism, some metaphysicians put forward dispositionalism as a key to overcome inductive skepticism. Before examining the dispositionalist approach to inductive skepticism in detail, we need to understand dispositionalism. To understand dispositionalism thoroughly, it is important to look at the two conceptions of properties at play as to nature's ontology: properties as dispositions or powers[25][26] and properties as categorical qualities[27]. Both dispositional and categorical properties are difficult concepts to be defined precisely. In the previous sections, I have briefly mentioned the distinction between dispositional and categorical properties yet haven't properly elucidated the concepts. Let us now clarify these concepts as much as possible.

Properties

Dispositional Properties: Dispositions or Powers

In the literature, there are several terms that have been used to describe what is meant by dispositions. One of these terms that I will use interchangeably with the term

[25] In this study, I shall use the expressions 'disposition' and 'power' interchangeably.

[26] See Ellis 1999, 2001, 2002, 2010; Mumford 1998; Molnar 2003.

[27] See Mumford 1998, pp. 20–22; Bird 2007, pp. 66–67; Ellis 2010 for attempts to clarify categorical properties.

‘disposition’ is ‘power’ (Locke’s term).[28] A disposition is a natural quality of an entity implying a tendency for behaving in a particular way under certain conditions. For example, sugar has certain dispositions and one of them is the disposition to dissolve in a hot beverage. A DNA molecule has certain dispositions, and one of them is the disposition to transmit genetic information from parents to offspring in cell division after fertilization and the other one is to make protein, another extremely complex macromolecule, made up of a long chain of chemicals called amino acids. When we put it like this, on the one hand, a disposition seems to be a genuine entity in the sense that it is shared by all soluble beings or all DNA molecules; on the other hand, it seems mysterious for not being a manifest quality like their size or shape.

Dispositions or powers of natural phenomena are conceived as beings that can act and be acted upon. That is to say, powers are closely associated with various sorts of causal interaction. The power’s act of showing itself in a causal interaction is known as its manifestation. The manifestation of a disposition/power takes place in response to some stimulus. To illustrate the relation of a disposition/power to its manifestation and to some stimulus, sugar is disposed to dissolve when put in a hot beverage, the DNA is disposed to transmit genetic information from parent to child through the egg and sperm cell when the cell cycle begins or to make protein, or to take another example, the glass is disposed to scatter when thrown to the wall.

[28] See Locke (2004), Book II, Chapter XXI. Also, among these terms are dunamis (Aristotle's term - see Aristotle (1998), Book V, 1019a, 1019b), ability, potency, capability, tendency, potentiality, proclivity, capacity, and so forth. They refer to the same thing ‘disposition’ more or less. See Choi, S. & Fara, M. (Spring 2012). Dispositions. In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/spr2012/entries/dispositions/

Each causal power of objects has one manifestation; each manifestation is typically a contribution to an outcome; an outcome is typically a combination of contributory manifestations in a particular causal interaction. Suppose that we put sugar, a slice of lime and a pile of clove into a cup of hot tea in order. Firstly, the exercise of causal powers of sugar makes a change in the tea and the tea becomes sweet. Likewise, when we put a slice of lime and a pile of clove into the cup, the exercise of the causal powers of lime and clove has particular impacts upon the taste of the beverage too. The causal powers of sugar would exercise together with the causal powers of lime or clove and manifest themselves; and hence, they all make a production out of this interaction. As the outcome, the tea most probably would become sour-like. This brings us to the fact that dispositional properties enable their bearers to do things, make a difference to the world, either by necessity or with some degree of probability (Ellis, 2001, p. 45).

For those who believe that dispositional properties exist, all of nature's physical objects or substances from the smallest subatomic particle to the universe itself, all of nature's chemical and biological phenomena are considered to have certain clusters of causal powers[29] that enable them to take part in wide range of activities, whether regular or irregular. Even some philosophers[30] consider that all the existences are nothing but aggregation of powers.

In *Powers*, in which we find a thorough defense of the ontological status of power properties, George Molnar (2003) specifies the basic features of powers. According to Molnar, features of powers are the following:

[29] Dispositional properties are natural "clusters of powers" in Stephen Mumford's terminology (2004, p. 171).

[30] Those who hold the view that all the existences are nothing but aggregation of powers are pandispositionalists. For instance, Mumford is a pandispositionalist.

I. Directedness. A power has directionality, in the sense that it must be a power for, or to, some outcome. It is this directedness that provides the prima facie distinction between powers (dispositions) and non-powers. …
II. Independence. Powers are ontologically independent of their manifestations. They can exist even when they are not being exercised and have not been exercised and will not be exercised. This peculiar feature of powers is a fertile source of philosophical puzzlement, leading to scepticism and anti-realism about such properties. …
III. Actuality. A particular strand of anti-realism holds that a power is really nothing over and above the possibility of manifestation. …
IV. Intrinsicality. Powers are intrinsic properties of their bearers, ...
V. Objectivity. Hume's notorious projectivist theory holds that dispositions have no objective existence in nature, but their appearance is generated by the psychological structure of human observers. I defend the objectivity of powers … (pp. 57)

The claim about the first feature as to powers is a controversial one, because he holds physical intentionality on a par with mental intentionality (ibid, pp. 60-80). There is already a huge debate about physical and mental intentionality in the literature.[31] So, the directedness feature of powers is open to discussion or rather it seems to be a more controversial feature than the other four features. If we leave that aside, I agree with power metaphysicians on that causal powers do exist in nature and with Molnar about the rest of the features.[32] Moreover, I also find the concept of power liberating. The concept liberates us from the idea of an external intervention on events, on our actions. It seems that things govern themselves without there being an external intervention, such as the existence of external laws that are imposed on a passive nature or the existence of some other kind of governor, by virtue of their intrinsic causal powers.

[31] See Jacob, P. (Fall 2010). Intentionality. In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/fall2010/entries/intentionality

[32] Nancy Cartwright too has described the distinctive features of dispositions. You may see her discussion here: Cartwright, N. (2007). What makes a capacity a disposition?. In M, Kistler & B, Gnassousou (Eds.), *Dispositions and Causal Powers* (pp. 195-206). Hempshire, Ashgate.

Categorical Properties

Dispositional properties are often contrasted with categorical properties. To put it roughly, categorical properties are the conditions in which things happen to be. To be more accurate, I think that it is possible to consider them as spatiotemporal or numerical features in terms of which we describe the states of things. The Lockean primary qualities of size and shape and the various structural properties of things are among the examples of categorical properties. For instance, roundness, or being made of metal are categorical properties. Unlike dispositional properties, the identities of categorical properties hinge upon not their behaviors, but their states.[33] They are thought of as non-dispositional, inert, passive entities.[34] By some thinkers categorical properties are also thought as entities forming the base for the dispositional ones.[35]

The Categorical/Dispositional Distinction

Even though the distinction between categorical and dispositional properties has appealed to philosophers in some way since Aristotle, it wasn't addressed intensely until contemporary metaphysicians raised issues concerning Humean metaphysics. As we said before, the most sophisticated formulation of Humean metaphysics is

[33] Some may object to this claim in the following way: round things roll, roundness of a round thing can also be its disposition in addition to its categorical quality. In return to that objection, one may argue that dispositional and categorical properties are like the two sides of a coin, every property is in some sense both dispositional and categorical. There are different positions about properties in the literature. See the next section "Basic Positions in the Literature".

[34] See Ellis, B. (2001). *Scientific Essentialism* Cambridge: Cambridge University Press.
Ellis, B. (2010). Causal Powers and Categorical Properties. In A, Marmodoro (Ed.), *The Metaphysics of Powers: Their Grounding and Their Manifestations* (pp. 133–142). London: Routledge.

[35] See David Armstrong (1997). *A World of States of Affairs* Cambridge: Cambridge University Press.

Lewis's Humean supervenience thesis. Judging from the way Lewis captured nature's essential structure and makeup, the fundamental properties in a Humean world are, or rather supposed to be, categorical properties. Primarily the categorical properties are distributed over the whole of space-time; the distribution of dispositional properties comes after the distribution of categorical properties. This feature of the Humean supervenience gives birth to a categorical/dispositional distinction. As concerns this distinction, the common assumption is that dispositional properties fundamentally involve conditionality in a way that categorical properties do not. Take fragility, for instance. Fragility is a disposition if and only if there are an associated stimulus and manifestation. A glass has fragility if it would bring about the manifestation (breaking) if it were in the stimulus condition (if fallen, thrown against a wall, so on). On the other hand, the shape or size of a glass does not entail such conditionality.[36]

Basic Positions about Properties in the Literature

We have described properties as to nature's ontology but haven't specified the stances metaphysicians adopted regarding them in the literature. There are two basic positions: property dualism and property monism. Property dualism is "the ontological thesis that dispositional properties are a fundamentally different type of property from categorical properties" (Mumford, 1998, p. 18).[37] Property monism, on the other hand, is "the ontological thesis that there is only one type of

[36] With reference to things I said in the footnote 29, one may object to that, and for instance, claim that a cylindrical vase and a rectangular vase will behave differently when they are placed on top of a hill downwards. There are different views about properties in the literature.

[37] Ellis (2001) and Molnar (2003) argue that there must be categorical properties irreducible to powers.

fundamental property" (ibid) and has two divisions: categorical monism and dispositional monism.

Categorical monism amounts to "the ontological thesis that there is only one fundamental type of property. All properties are categorical properties; 'dispositional properties' do not exist" (ibid, p. 19). Dispositional monism is "the ontological thesis that there is one type of property. All properties are dispositional properties; categorical properties do not exist" (ibid).[38] Dispositional monism is also called pure powers view (Jacobs, 2011). On the pure powers view, "[t]here is nothing to a property but its causal role. Properties are powers and *nothing but* powers" (original emphasis, p. 84).

In addition to property dualism and property monism, there is an irenic position regarding the nature of properties, which is known as the Limit View. Put forward by Martin and Heil (1999), the Limit View is that "[e]very property is in some sense both dispositional and categorical" (Armstrong, Martin & Place, 1996; Martin, 1997; Martin & Heil, 1999[39]; Heil, 2003, 2005).[40] The Limit View is also called the powerful qualities view (Jacobs, 2011).[41]

---

[38] See Popper, 1959; Harré, 1970; Harré and Madden, 1975; Shoemaker, 1980; Mumford, 2004; Bird, 2005, 2007; Chakravartty, 2007; Whittle, 2008.

[39] Martin & Heil (1999) describe the view this way:

> Dispositionality and qualitativity are built into each property; indeed, they are the property. … What we propose boils down to a surprising identity: the dispositional and the qualitative are identical with one another and with the unitary instrinsic property itself. (pp. 46-47)

40 Choi, S. & Fara, M. (Spring 2012). Dispositions. In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/spr2012/entries/dispositions

41 Jacobs thinks that the powerful qualities view is the correct account of properties within the dispositionalist framework. After specifying the weaknesses of the current powerful qualities view, he attempts to revise it by proposing the view he calls "the truthmaker view". The difference between these two views is not significant for the purposes of our thesis. Therefore, I will not dwell on its details here.

Thinkers also look at properties with the essential vs. accidental distinction. This distinction is affiliated with the traditional metaphysical view essentialism, the view that at least some objects have essences, and is described in many ways. One of these ways is the modal description. When we give a modal description of a concept, here 'property', what we do is to characterize the concept in modal terms, i.e., necessity, contingency and possibility. Thus, according to the modal description, a property is an essential property of an entity, if the entity exists then it must have the property. Otherwise, it is an accidental property. That is to say, an essential property is one without which the entity could not exist whereas an accidental property is one without which the entity could still exist. Therefore, 'must' implies necessity here. In other words, to be an essential property is to be necessary to an entity in every possible circumstance in which the entity exists. Thus, an accidental property reflects only a possibility. A property can be both dispositional and essential or accidental. Alternatively, a property can both be categorical and essential or accidental.

So, these were the basic positions about properties;[42] now we can continue with the views categoricalism and dispositionalism.

Categoricalism vs. Dispositionalism

Categoricalism

As is said before, categoricalism is that the relation between the property itself and its associated roles (i.e., theoretical, nomic or causal roles) is simply contingent (Armstrong, 1989, 1997; Lewis, 2009). Contingent character/contingency of this relation paves the way for some to claim that categoricalism entails quidditism. Let

[42] For more information about properties in general, see Swoyer, C. & Orilia, F. (Winter 2011). Properties. In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/win2011/entries/properties

me briefly sketch quiddity and quidditism. *Quiddity,* as something primitive, is thought to be the "self-contained" nature of a property that establishes its essence (Armstrong, 1997, p. 80). It is whatness of things. And 'quidditism' refers to the acceptance of quiddities and a certain independence between them and the roles associated with a property. To be more specific, on quidditism, the property's dispositional behavior - if any- is independent of its quiddity/essence; a property's powers are not essential to it. For instance, repelling positively charged particles is not essential to being negatively charged. The property of being negatively charged could exist without giving its bearers the disposition to repel positively charged particles. An object with a property of being negatively charged repels positively charged particles in this world while it might not repel them in other world. So, categoricalism entails quidditism.

Having a categorical property seems to make the nature of its bearer unknowable due to quiddities it possibly possesses. If a particular property can exist (can be instantiated) with a completely different causal contribution than the one it actually has then what does its nature consist in? To take the relationship between quiddities and their theoretical roles as a contingent relation veils the nature of properties in mystery. As mentioned in the previous section on dispositional properties, the nature of dispositions are mysterious as well – for a different reason though; yet, in comparison to categorical properties, dispositional properties have a better chance in terms of rendering the nature of their bearers capable of being known because dispositionalism avoids quidditism. We will see that these help dispositionalists propose a solution to overcome inductive skepticism. Hence, let us now look at dispositionalism closely.

Dispositionalism

Dispositionalism, also called the new actualism, neo-Aristotelianism and metaphysics of powers, is a rebirth of an old picture of reality - one that is portrayed in Aristotle[43] and Aquinas[44]. In contemporary metaphysics, dispositionalism is the view that accepts dispositional properties (that is, powers) or dispositional essences (that is, a distinctive set of powers) in nature's ontology. As opposed to categoricalism, on dispositionalism, the relation between properties and their associated roles, e.g., theoretical, causal or nomic roles, is a necessary relation.

The metaphysical infrastructure of dispositionalism is fundamentally different from that of Humean theory or nomic necessitarianism. According to the Humean account of nature, the world is ungoverned whereas on the nomic necessitarian account, it is governed by laws of nature. On dispositionalist account of nature, however, it would not be wrong to think that the world is self-governed (Mumford, 2004).

Things in nature are intrinsically powerful in virtue of their properties, which make them active; they are able to govern the course of events themselves without there being an external governor. In this regard, for dispositionalists, nature is intrinsically active. Powers, which are metaphysically the most basic entities in nature's ontology in the sense that they are not reducible to anything else within the dispositionalist framework, are the "building blocks of reality"[45], the activators of events in the universe.

---

[43] See Aristotle (1998). *Metaphysics*. H. Lawson-Tancred (trans.), London: Penguin. Also see Kistler, M. & Gnassounou, B. (Eds.) (2007). *Dispositions and Causal Powers* (pp. 3-7). Hempshire, Ashgate.

[44]Geach. P. T. (1961). Aquinas. In G. E. M. Anscombe & P. T. Geach (Eds.), *Three Philosophers* (pp. 65-125). Oxford: Blackwell.

Contrary to the Humean ontological picture, dispositionalists argue that there are necessary connections among distinct entities in nature. And it is *de re* necessity: necessity by virtue of the things. For instance, Mumford (2004) describes *de re* necessity as "necessity in nature: in things, rather than in words or logical form" (p. 166). He defends dispositionalism without adopting essentialism, and accordingly, claims that simply dispositions and causal powers of things provide *de re* necessity to the world.[46]

In Ellis's terminology, however, *de re* necessity, also called metaphysical or "real" necessity, is grounded in the essences of things (2001, p. 11; 2002, p. 109-110). Metaphysical necessities in nature are of two kinds, "those that are grounded in the individual real essences of things and those that are grounded in the natural kind essences of things" (2001, p. 11). For the purpose of this work, it is the metaphysical necessities grounded in the natural kind essences of things that concern us.

As Ellis takes it, the first property of a metaphysical necessity is to be real/genuine. And the second property of a metaphysical necessity is to be knowable a posteriori. That is to say, a metaphysical necessity is "discoverable by empirical investigation" (Ellis, 2002, p. 18).[47]

---

45 Anna Marmodoro who directs the project 'Power Structuralism in Ancient Ontologies' at Oxford University puts it in this way. See Marmodoro, A. (2011). About the Project. [PowerPoint slides]. Retrieved from http://www.power-structuralism.ox.ac.uk/about_the_project

46 Dispositionalists use the term *de r*e necessity interchangeably with metaphysical and real necessity.

47 Table 3: Types of Necessities

Logical Necessity	Analytic Necessity/ Linguistic Necessity	Natural Necessity	Physical Necessity	Metaphysical Necessity

The Dispositionalist Approach to the Problem of Induction

Some dispositionalists argue that there can be a solution to the problem of induction. The dispositionalists who are optimistic about a solution are dispositional essentialists, in particular Ellis. According to Ellis (2002), dispositional essentialism portrays a world that is different from the inactive world of mechanism (Humean world), in which

> (a) inanimate matter is not passive, but essentially active;
> (b) the actions of things depend on their causal powers and other dispositional properties;
> (c) dispositional properties of things are genuine properties, and intrinsic to the things that have them;
> (d) the essential properties of things always include dispositional properties;
> (e) elementary causal relations involve necessary connections between events, namely between the displays of dispositional properties and the circumstances that give rise to them;
> (f) the laws of nature describe the ways that members of natural kinds are logically required (or are necessarily disposed) to act, given their essential natures; and
> (g) the laws of nature are metaphysically necessary, because anything that belongs to a natural kind is logically required (or is necessarily disposed) to behave as its essential properties dictate. (p. 59)

According to this, the fundamental properties in the sciences are thought to possess essences which are the grounds for the laws of nature that concern these properties; laws of nature are facts about the essential natures of natural kinds; and since the behavior of the fundamental properties stem from their essences, the laws that systematize this behavior are therefore true of necessity.

-grounded in logical form. e.g., the proposition that the sun exists or does not exist.	-sentences that are true in virtue of meanings of words. e.g., the proposition that 'a bachelor is an unmarried man'.	-natural necessity as due to contingent relations between universals	-natural necessity as metaphysical necessity	-physical necessity is just metaphysical necessity, for a dispositionalist.	-propositions that are true in virtue of the essences of things. e.g. the proposition that water is H_2O.

This view has its roots in Harré & Madden (1975), and Shoemaker (1980), and was thoroughly developed by Ellis (2001, 2002), and most recently articulate and defended by Bird (2007).[48] To solve the problem of induction, dispositional essentialists aim to take the issue one step further than nomic necessitarians did in the sense that they claim to establish a link between the existence of some unchanging regularity and our means of representing that regularity with some justification.

Ellis's Dispositional Essentialist Solution

Ellis calls his overarching metaphysical stance 'scientific essentialism'. The fundamental concepts of the view scientific essentialism that take place within nature's ontology are those of natural kind and kind essence (the unchangeable essence of a kind).[49] A natural kind is a category of stable entities in physical world.[50] As Ellis (2001) conceives it, a natural kind is a generalized universal (p. 97).[51] Also, on scientific essentialism, not only intrinsic causal powers but also

[48] Bird's position is a bit different though. See Groff, R. (2012). Whose Powers? Which Agency?. In R, Groff & J, Greco. (Eds.), *Powers and Capacities in Philosophy: The New Aristotelianism* (pp. 207-227). New York, NY: Routledge.

[49] Ellis (2001) indeed describes two types of natural kinds such as "fixed" and "variable" natural kinds. Fixed natural kinds are the ones that "[h]ave all of their intrinsic properties and structures essentially" (2001, p. 21). Among the examples of fixed natural kind are fundamental particles. The variable natural kinds are on the other hand the ones that "[h]ave some of their intrinsic properties or structures accidentally" (ibid). The examples he gives are "metallic crystal" and "biological species". As concern biological species, Ellis quotes, "plausibly, these may be regarded as clusters of closely related natural kinds, whose essences are their genetic constitutions" referring to "(Wilkerson, 1995)"" (ibid).

[50] For more information, see Bird, A. & Tobin, E. Natural Kinds. (Winter 2012). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/win2012/entries/natural-kinds

[51] "They are generalized in two ways: (1) in respect of *category*, and (2) in respect of *position in a hierarchy*" (Ellis, 2001, p. 97).

capacities and propensities are among the genuine properties of things (Ellis and Lierse, 1994).

The main idea of this view is as follows. When a natural object is a member of a natural kind, this means that it is intrinsically and essentially disposed to act in certain kinds of ways in certain circumstances. The laws of nature are the facts about the way the members of corresponding natural kinds are essentially disposed to behave. And they are metaphysically necessary in the sense that "[t]hey are all true in every possible world" (Ellis, 2002, p. 101). For instance, it is a law that a water molecule is essentially disposed to evaporate. This holds true in this world and would hold true for any possible world as long as it contains the same natural kind 'water molecule'. In other words, the essential natures of natural kinds ensure that members of the corresponding kinds would act in the same way given the same conditions, whether in this actual world or in any possible world (Ellis, 2001, pp. 249–53).

I think that dispositionalism in general, and scientific essentialism in particular, provides us with a metaphysical infrastructure better equipped to deal with the problem of induction than regularity theory or nomic necessitarianism. As a matter of fact, as Ellis (2001) points out, essentialism

> promises to transform our thinking about scientific rationality and the theory of inductive reasoning. If one believes, as Hume did, that all events are loose and separate, then the problem of induction is probably insoluble. Anything could happen. But if one thinks, as scientific essentialists do, that the laws of nature are immanent in the world, and depend on the essential natures of things, then there are strong constraints on what could possibly happen. (p. 283)

Ellis's view about induction, I take it, goes as follows: induction is making an inference from observed matters of fact to unobserved matters of fact. And as concerns the problem of induction, he (2002) says:

> From the point of view of an essentialist, the problem of induction appears very different, for it reduces to that of discovering what natural kinds there are, and identifying their essential properties and structures. Essentialists hold that once we know the essential natures of things, we know how they must be disposed to behave whenever or wherever, on in whatever world, they might exist. There is no problem of inference from some to all, therefore. The presumption is, rather, in favour of strict uniformity. If there is good reason to believe that something is a member of a natural kind, and good reason to think that it has such and such a nature, then there is good reason to think that everything of that kind must have this same nature. (p. 135)

From this description, we understand that the kind essences and the dispositional character of their nature do the main work to overcome inductive skepticism in the essentialist solution to the problem of induction. The existence of the kind essence refers to the existence of uniquely clustered causal powers, and its existence sets the ground for the differentiation among beings. And the essence being dispositional in character sets the ground for behaving distinctively and restrictively, not randomly or arbitrarily. Members of the corresponding natural kinds tend to act depending on their essential dispositions. Time-invariant regularities in nature stem from the immutable essential nature of the corresponding kinds. This is clearly different from how Armstrong takes the source of time-invariant regularities in nature. In the Armstrongian world, the source is the nomic necessitation relation that holds between universals. Without there being the necessitation relation, things could act in arbitrary ways.

To illustrate the essentialist take with an example, let us consider *electrons.* An *electron* is thought to be one of the natural kinds (a fixed natural kind as Ellis would classify). He (2001) specifes,

> For anything to be an electron, it must have a certain mass, charge, spin, stability, and so on and therefore be capable of acting on, or interacting with, other particles and fields in certain ways, depending on the laws of action of these properties, and the powers, capacities, and properties of the things on which it acts or which act on it. If anything lacked any of these causal powers,

> capacities, or propensities, it would not be an electron. Unit charge, unit mass, and spin ½ are essential properties of electrons, and electrons are by their very nature bound to act and interact as these properties determine. (pp. 48-49)

That is, scientific essentialists understand the unchanging essential nature of kinds as comprised of certain causal powers, capacities or propensities, whether manifested or not. One of the dispositions of an electron in virtue of, for instance, 'being negatively charged' is the disposition toward repelling another electron or attracting a positively charged particle. Since having that disposition is the part of the nature of an electron, in principle electrons cannot fail to manifest repelling other electrons or attracting positively charged particles.[52] Therefore, having a particular essence causally explains why members of the corresponding kinds act in the way they do. When we encounter an electron-like entity that so behaves, we are justified in believing that it is an electron by inference to the best explanation: its being a member of the kind with that particular essence best accounts for its repelling another electron or attracting a positively charged particle.

Having a particular essence also helps working scientists make a range of other predictions about natural kinds. Natural kinds are somehow in relationship with each other. To the extent that the essential nature of kinds is revealed, it becomes possible to make further inductive inferences and other predictions that it entails, including ones about relations among kinds. Therefore, from the scientific essentialist perspective, the problem of induction eventually boils down to the identification of the existing natural kinds and the discovery of their essential natures.

[52] The essentialists anticipate that all the electrons throughout the universe would behave in the same way under similar circumstances owing to their essential nature.

To summarize, dispositional essentialists presuppose that natural kinds do exist, and they aim to make a stride in the problem of induction anticipating that there are supposed to be strict uniformities in nature due to natural kinds. Accordingly, the essentialist argument against inductive skepticism runs as follows: Natural processes such as the generation of electromagnetic fields by electrons, the vaporization of water, and the replication of the DNA, etc. are activated and brought about by causal powers of relevant natural objects. If some particular, say a DNA sample, is known to belong to a natural kind K, the kind *DNA*, whose essence is known to involve a particular disposition to bring about a certain outcome, e.g., to transmit genetic information, if appropriate conditions are met for the DNA's causal powers to be able to manifest themselves, it is unavoidable for it to act in a certain kind of way, that is, to transmit genetic information. So, for an essentialist, this explains why there are supposed to be strict uniformities in nature. Hence, whenever there is a DNA-like entity that so behaves, they think, we are justified in believing that it is a DNA since it is anticipated that all DNA instances of the natural kind DNA would act in that way under similar circumstances. Hence, to cast Ellis's argument,

x behaves like Kind K

---

x is a member of K

x is a member of K

---

x has properties F, G, …

The obvious question that follows from here now is whether inductive skepticism can be overcome in this way as Ellis put it forward.

Critique of Ellis's Intended Solution

Even though Ellis's proposal seems to be more sophisticated than Armstrong's proposal, I will nonetheless argue that dispositional essentialism cannot overcome inductive skepticism. First, here is a formulation, which summarizes the case for dispositional essentialism, which will also help us when addressing the problems with the essentialist solution:

Let us assume there is a power P which, under appropriate conditions C1, necessarily causes manifestation M1. We will symbolize this as follows:

$P + C_1 \Rightarrow M_1$

This is a regularity, let's call it R1.

But if P is under other conditions, C2, then M2 is its manifestation.

$P + C2 \Rightarrow M2$

Let's call this regularity R2.

And so on, for various conditions P can be active in. So, a power can have very many manifestations in different circumstances. Once the essential nature of kinds is determined, then one can have the opportunity to make inductive inferences and predictions rationally.

One way to question the essentialist's move is the following: Just as nomic necessitarianism, essentialism too faces *the problem of discovery*: how can we know that there is a kind K? To take some phenomenon or object to be a member of a natural kind does not automatically ensure membership in a particular kind. In

principle, that phenomenon may not be a member of any natural kind at all. For instance, fire, once thought to be one of the four basic elements is not a natural kind.

Secondly, *the problem of classification of phenomena* holds for essentialism just like there was one for nomic necessitarianism: for any given object/phenomenon, how can we know which kind K it is, essentially? To classify some phenomenon or object as a natural kind does not ensure membership in a particular kind. In principle, that phenomenon may be a member of a different kind or not classifiable as a kind. The case of biological species is a remarkable example. The evolution of species indicates to us that it is hard to find a property that pertains to a particular species only, and not present among the properties of other species. Consider the case of viruses. The fact that viruses mutate so rapidly jeopardizes the determination of "necessary and sufficient conditions for membership" in a specific virus kind (Bird and Tobin, 2012).[53] That is, given the changeability of the set of necessary and sufficient properties for kind membership, we may encounter examples of previously thought kinds turning actually to be problematic as kinds. (We have made the same point when discussing Sankey's proposal.)

The third of the main problems that the essentialists need to face is *the problem of the individuation of kinds*. That is, how can we know which properties are entailed by membership in kind K? How can we know for certain that such-and-such property is essential to a certain natural kind? In principle, it is always possible for working scientists to not be able to identify or to misidentify the essential natures of kinds. One significant reason is that since it is not possible to observe all of the appropriate conditions, we cannot know how powers are disposed to behave under all

[53] See Bird, A. & Tobin, E. Natural Kinds. (Winter 2012). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/win2012/entries/natural-kinds

circumstances. For instance, it is considered that the main cause for skin cancer is Ultraviolet (UV) radiation from the sun; however, according to the results of a recent research, exposure to ultraviolet light seems to reduce the blood pressure and hence raise the quality of one's overall health "because the benefits of reducing blood pressure far outweigh the risk of developing skin cancer" (University of Edinburgh).[54] So, on the one hand, it is considered that someone who is exposed to ultraviolet light shows a tendency towards getting skin cancer, depending on the other circumstances in the environment; on the other hand, she may not. Yet since it is impossible to know all the appropriate conditions in the environment, it gets hard to know how the participating powers in a causal interaction are going to tend towards behaving under all circumstances. This example indicates to us that even within the dispositional essentialist framework, the problem of induction still applies.

The fact that we cannot complete the discovery of all the variant conditions an object can be found in gives rise to an even greater problem. Let me explain this problem now.

Challenge from Nature's Unmanifested, Hidden Causal Powers

"Nature loves to hide."
Heraclitus (*Fragments*, B123)

There can be some causal powers of kinds which we do not know. For instance, they can be masked by another causal power or powers in the environment, or they can be hidden causal powers, which haven't manifested themselves yet at all but will do so

[54] University of Edinburgh. (7 May 2013). Sunshine could benefit health and prolong life, study suggests. *ScienceDaily*, Retrieved May 20, 2013 from http://www.sciencedaily.com/releases/2013/05/130507195807.htm

when their appropriate circumstances obtain, later. In principle, these two possibilities hold for every natural kind in nature.[55] I think that especially the case of hidden causal powers poses a real challenge in the metaphysical sense against the essentialist assumption in favor of uniformity in nature and the intended essentialist solution to the problem of induction. Let me show it how it does, now.

Think about the skeptical possibility that some of the regularities that we have observed so far change prominently or cease to repeat at some point in the future. Likewise, think about the skeptical possibility that we begin to observe some novel kinds of regularities that we have formerly never encountered. In other words, consider that some natural kind K begins to act in a significantly different way from it normally did. In principle, there is nothing in the metaphysics of powers that rules out the possibility of changes, even massive ones, in the course of workings of nature. This is simply because causal powers can exist unmanifested and there can be not-yet-manifested, in other words hidden, causal powers of objects or processes in nature.

If it is true that nature is best captured by the tenets of the metaphysics of powers, and that causal powers are genuine properties of things, then I find it conceivable that objects or processes can in principle have unmanifested, hidden causal powers in addition to their manifested ones. Some causal powers in nature might have never manifested themselves for different reasons, e.g. due to intervening powers to the processes, simply the lack of appropriate conditions for manifestation, or else. Depending on change of conditions in the environment, they may become

[55] I prefer to divide causal powers into two categories: the passive type and the active type yet the members of both types are genuine. Accordingly, I take the unmanifested powers as the passive type in the sense that they have never been activated and made contributions to causal processes in nature whereas the already manifested ones fall under the category of the active type – they are activated, participated and still participate in causal processes.

active and ultimately manifest themselves. In the case that they manifest themselves, we possibly begin to observe new behavioral patterns in nature.

For instance, the result of a recent study from marine biology can set an example regarding the manifestation of a hidden causal power of a natural kind.[56] Here's how. Marine mammals are examples of biological natural kinds. According to this study, a marine mammal, actually a Begula whale named NOC, was able to mimic the pattern of human speech spontaneously for four years at his stay at the National Marine Mammal Foundation (NMMF) in San Diego. Researchers believe that NOC learned to mimic humans' conversation by listening to his handlers speak underwater and on the surface. It has already been observed that Begula whales have dispositions toward emitting sound in many different ways including "high-pitched, resonant whistles and squeals, clucks, mews, chirps, trills, and bell-like tones" (Haley, 1978).[57] However, this study reveals something very unusual. NOC was heard communicating not via a whale's normal nasal squeals and whistles, but by vibrations of the larynx, just like human beings. In fact, NOC's performed his mimicry so successfully that it was hard to distinguish it from a real human voice, his handlers report.

Suppose that this marine mammal's very act of 'talking' like a human is an example of the manifestation of a formerly inactive, and yet hidden, causal power – one that is presumably related to whales' cognitive dispositions in general.[58] Were whales regularly to be around humans, be exposed to human speech, namely were

---

[56] Ridgway, S. & Carder, D. &Jeffries, M. & Todd, M. (October 2012). Spontaneous human speech mimicry by a cetacean. *Current Biology*. Vol. 22, Issue 20, R860-R861.

[57] Haley, D. (Ed.) (1978). *Marine Mammals*. Seattle, WA: Pacific Search Press. Seattle, WA. See also Begula Whales - Communication and Echolocation. Retrieved from http://www.seaworld.org/animal-info/info-books/beluga/communication.htm

[58] As opposed to due to a genetic mutation. If this trait is due to a mutation then this would be an example of the problem of individuation of kinds.

whales to be exposed to change of condition in their environments, they would be able to exhibit such unfamiliar behaviors. So, there can be unmanifested, hidden causal powers of natural phenomena and if the appropriate conditions are met, they may become active and manifest themselves.

To reinforce the claim, let us now consider another example, one from a recent study in molecular biology according to which there are also four-stranded /quadruple helix DNA structures at work in human cells. DNA, namely the essential molecule of all forms of life, contains two strands of building blocks called nucleotides intertwined to form a double helix. Each nucleotide has three parts: a phosphate group, a sugar molecule and one of four nitrogenous bases – adenine, guanine, thymine, and cytosine – that hold DNA together and encode our genetic information. According to a newly published paper in *Nature Chemistry*[59], scientists have revealed that there are also quadruple-helix DNA structures in our cells, especially in the areas that are rich in guanine.[60] The research in question shows that these unusual DNA structures are more likely to occur in the genes of cells that are rapidly dividing, such as cancer cells. Accordingly, researchers specify that quadruple helix structures exist in ways that might possibly relate to cancer. That is to say, these unusual structures possibly have certain important biological functions, put in dispositionalist terms, certain important dispositions.

How is this research related to the critique of Ellis's essentialist solution to the problem of induction, then? Let me explain how. Firstly, DNA is a fundamental biological natural kind with a dispositional essence that falls under the category of Ellisian variable natural kinds. Secondly, on scientific essentialism, as we said, the

[59] Biffi, G. & Tannahill, D. & McCafferty, J. & Balasubramanian, S. (2013). Quantitative visualization of DNA G-quadruplex structures in human cells. *Nature Chemistry,* 5, 182-186.

[60] This is way these DNAs are dubbed G-quadruplexes.

dispositional essence of a kind is comprised of a distinctive set of causal powers, capacities and propensities; therefore, like any other natural kind, the DNA kind too has an essence which is comprised of certain causal powers, capacities and propensities -- a particular DNA molecule is disposed to behave in certain ways under certain conditions by virtue of its essential properties. Thirdly, if the essence of any natural kind can in principle include unmanifested, hidden causal powers in addition to its already manifested ones, DNA can have unmanifested causal powers too. And fourthly, since we accept the existence of hidden causal powers in nature as a conceivable possibility, we take the activation and the manifestation of these powers at some point over time as a conceivable possibility too. Therefore, if there is substantial change of condition in the environment, one or several unmanifested causal powers of a particular DNA can activate, manifest themselves, and hence, make contributions to the causal processes – they either initiate some entirely new process or influence the ongoing one(s).

The fact that human cells contain both types of DNA structure in function indicates to us that DNA is dynamic and evolving.[61] Given this, and with reference to the abovementioned ideas on the types of causal powers, I think that there can be *at least* two explanations in parallel with the dispositionalist worldview as concerns the evolution of quadruple helix DNA structures in human cells, and one of the explanations, the second explanation, is compatible with the case of hidden powers.

First explanation would go as follows: The evolution of the quadruple helix DNA structures in human cells is the outcome of the co-operative work of the already manifested causal powers of DNA and the other causal powers in the environment. In the course of time, active causal powers of DNA were affected by

[61] It is possible that the structure of DNA was originally not double helix but something else. Still both forms, first double helix and now the quadruple helix might have evolved.

other causal powers in the environment, and consequently, they altogether paved the way for the evolution of the unusual DNA structures which, most probably, have different dispositions from the ones forming the double helix structures in cells. It is still under investigation what specific function or functions the quadruple helix structures have; yet, the fact that they are more likely to occur in rapidly growing cells like cancer cells make researchers think that they and double helix structures might also have different dispositions from each other in addition to the same dispositions they have.

Second explanation would go as follows: The evolution of the quadruple helix DNA structures is the outcome of the co-operative work of newly and already manifested causal powers together with the other working causal powers in the environment. In the course of time, one or more hidden causal powers of DNA were activated depending on the circumstances and worked with its already manifested powers and the other powers in the environment. And they altogether led to the evolution of these unusual structures. When the possibility of hidden or unmanifested causal powers is taken into consideration, the second explanation becomes as equally reasonable as the first explanation in terms of reflecting the truth behind the evolution of quadruple helix DNA structures. In fact, I think that the role of the not-yet-unmanifested, hidden causal powers behind the evolutionary processes can be much more common in nature than we imagine.

Like in the case of DNA, the presence of hidden causal powers is in question for every natural kind, including the fixed ones in Ellis's terms. One day some drastic change may occur in the universe, and electrons or water molecules would start acting in a totally different way, for instance. This brings us to the skeptical possibility we mentioned at the beginning of this section. If there are such causal

powers of natural phenomena, and if they emerge, some of the regularities we have observed so far may change prominently or cease to repeat at some point in future, or alternatively, we may begin to observe novel kinds of regularity that we have not encountered before.

To know the essence of a natural kind is to know its dispositions. However, to know that does not necessarily mean that the future will resemble the past because it is metaphysically possible for the natural kind members to act in different ways together with change in conditions in nature. Therefore, knowledge that all kind members are disposed towards doing whatever they do will only license inference to some future fact on the assumption that there are no unmanifested, hidden causal powers of natural kinds or on that they will remain hidden. Yet, this is something that cannot be pre-established for certain by inference to the best explanation or in any other way. Nature is in flux and hidden causal powers are likely to become apparent in flux, but we cannot know under which circumstances and when. A skeptic would worry whether she has any grounds for thinking that the members of a given natural kind won't start acting differently at some point in future.

In addition to all these, there is also another way one can question the dispositional essentialist's move. To discover the essential nature of a kind requires a long series of observations. Consider the skeptical possibility that some accidental properties do things regularly in nature and that they do things in such a good way that it allows one to make good inductive inferences. I think that nature being dispositional in character, in principle, allows accidental properties to do things regularly under appropriate conditions in nature. If something has accidental properties alongside its essential properties and do things regularly, how then can we

determine which of the properties are essential and which are accidental? Also, how can we accurately determine which of the regular patterns is engendered by essential properties and which is engendered by accidental properties from experience? It seems that which properties scientists will deem essential to explain a phenomenon's behavior depends upon what behavior they happen to be observing. But in reality, those properties would be accidental properties which the phenomenon has had under a certain condition in the universe. So, it seems that the issue about the appropriate conditions returns to haunt the dispositional essentialists again. Even if there is a mind-independent reality about the essential and accidental properties of kinds, which Ellis thinks there is, we may not know it precisely from experience at least for some phenomena.

Furthermore, it is possible to question the essentialist's move in the following way as well: Let us grant that if a regularity (say, that gas burns with blue flame) holds in our experience, it means that it holds in nature generally or at least in the next instance. Yes, but which regularity should we project to the future when we make a prediction? That it is blue, that it is cold colored or just that it is colored? How general, how specific should I cast the net for expecting "the same" property or event to occur? The same to what extent and in what respect? Especially given the problem of individuation of kinds, we are more perplexed to choose which regularity to project to the future and to expect the properties or events to occur. An essentialist does not tell us anything on this issue, how to choose a regularity, to what extent and in what respect.

Suppose that the dispositional essentialist responds by saying that we could project every one of these properties. But this is not a viable option as Nelson Goodman (1955) has shown us in *Fact, Fiction and Forecast.* Goodman drew our

attention to the "new riddle" of induction coining the predicate 'grue'. Something is grue iff 'either it is observed by today and and is green or it hasn't been observed before tomorrow and is blue. If I observed something to be green, then I've also observed it to be grue. If I project greenness I should expect the next instance of that type of thing to be green. If I project grueness, I should expect the next instance to be grue, that is, blue! Surely we should not project grueness. Even if *some* regularities we now observe and have observed in the past shall continue to be just like we observed them, exactly which regularities are those?

To come to the point, dispositionalists have to do something in order to avoid Goodmanesque problems arising from the possibility of radical re-conceptualization of the world. For instance, Ellis (1998) can say "from the standpoint of a scientific essentialist, date- or observation-dependent properties like grue and bleen cannot be characteristic of kinds" because, on essentialism, the laws of nature are necessary and spring from the intrinsic nature of kinds; given this, it is metaphysically impossible for things to act in arbitrary ways or date-dependently (p. 123). Therefore, dispositional essentialists can try to avoid the challenge posed by the grue paradox in this way. However, the question to which I intend to draw our attention at the beginning of this section still remains: which regularity should we project to the future when we make a prediction? Since the matter of unknowability of all conditions still holds, we are a bit unguided here. We are looking for whether there are good inductive strategies. Yet, here in the absence of a specific guide, it seems that the essentialist's strategy hasn't vindicated yet for that reason, along with the aforementioned other reasons.

Ellis (2002) would claim that the problems concerning how natural kinds are to be identified and their causal powers revealed are "[t]he kinds of doubts and

concerns that working scientists are accustomed to, and know how to handle" and add, "They are not irresolvable sceptical doubts like those generated by Humeanism" (p. 136). To put it differently, he would argue that dispositional essentialism can avoid this challenge by claiming that such problems stem from lack of knowledge.

These "kinds of doubts and concerns" can indeed be hardly resolvable, more for epistemological reasons. Knowing the essential nature of a kind is to know its essential causal powers/dispositions in the first place. Yet, in order to determine the essential causal powers of a kind, as we said, we need to determine the appropriate conditions for their manifestations as well. With reference to all these points, therefore, how do we know that we properly completed filling the following formulation?

$$\mathrm{P} + \mathrm{C} \xrightarrow[necessity]{} \mathrm{M}$$

For instance, suppose that a power which manifested itself before no longer manifests itself under similar circumstances. When we observe such a case, we would attribute this to a change in the conditions. But, since our knowledge of the relevant causal powers or required conditions, or both, can be incomplete and even sometimes misleading, we may never be certain of whether we completed this formulation properly in the first place. So, even if there are some time-invariant regularities in nature, we may not get to know them properly from experience. The solution to the problem of induction is supposed to be an epistemological solution ultimately. However, it seems that the metaphysical/ontological solution does not lend a hand to the epistemological solution here. Even though Ellis thinks that problems are resolvable problems, as we have seen, particularly given the threat by unmanifested, hidden causal powers in nature, it can indeed be hard for scientists to

resolve them. So, I conclude that, as it stands, Ellis's intended solution cannot overcome inductive skepticism.

Lowe's Dispositional Essentialist Solution

Another solution, or rather dissolution, to the problem of induction is proposed by the dispositional essentialist E. J. Lowe. He thinks that if the concept of a law of nature is understood from a novel perspective, the problem of induction might be dissolved. I will begin by briefly presenting his view about nature's ontology, in particular natural laws, then continue with his argument about induction, and lastly argue that his argument cannot dissolve the problem of induction.

Lowe's argument about the problem of induction takes places in one of his earlier papers. Yet his later works *Kinds of Being* (1989), *The Four-Category Ontology* (2006) and "Two Notions of Being: Entity and Essence" (2008) help us understand his views/position much better. Therefore, I will look at all of them alternately as I proceed. In *Kinds of Being* (1989), Lowe develops a normative account of dispositionality that has Aristotelian roots. The normative account of nature is usually associated with Aristotelian metaphysics and does not have many defenders today for it presents a worldview that does not tally with the modern scientific one. On this account, objects are considered as having a proper place where they ought to be and thus having a *telos* or final cause. For instance, seeds strive to be adult plants and that is why they grow. Lowe, however, aims to take this normative account, or teleological conception, of nature further and make it attractive for the modern scientific view of the world. He understands law statements as statements about the natural behavior of kind members in the following way: a seed

ought to grow; it is natural for a seed to grow if appropriate conditions for it to be able to grow are met in the environment (1989, Ch. 8).[62]

In a later work, "The Four-Category Ontology", Lowe (2006) presents a comprehensive argument about ontology consisting of objects, kinds, attributes, and modes. He thinks that whatever exists can be categorized in four ways as follows: substantial universals, substantial particulars, non-substantial universals and non-substantial particulars. Substantial universals are kinds; and kinds are instantiated by substantial particulars, namely objects. For instance, there is a kind *electron*, and a particular electron is an instance of the kind *electron*. Substantial universals, kinds, are characterized by non-substantial universals, namely properties or, as he prefers to call them, attributes. [63] For example, the kind *electron* is characterized by carrying the property of the unit negative charge. Non-substantial universals, properties, are instantiated by non-substantial particulars, namely modes. For example, the property of the unit negative charge is instantiated by a particular unit negative charge, namely, "this unit negative charge", of a particular electron. Substantial particulars, objects, are characterized by non-substantial particulars, modes. Objects, particular electrons, are characterized by their modes, their unit negative charges (2006, p. 93).

Among these four categories, Lowe claims that natural laws concern substantial universals, that is, kinds. Laws "[r]elate primarily to sorts or kinds rather than to individuals or particulars", and only "derivatively, relate to individuals, inasmuch as individuals instantiate this or that sort or kind" (1987, p. 333) and are

[62] It is possible for some seed not to grow if intervening factors preventing it from growing are in force in the given environment. Lowe allows for the possibility of exceptional cases to be seen in nature. We will come back to this point.

[63] In his opinion, "An object O may exemplify an attribute A in either of two ways. O may instantiate a kind K which is characterized by A, in which case O exemplifies A *dispositionally*. Alternatively, O may be characterized by a mode M which instantiates A, in which case O exemplifies A *occurrently*" (2006, p. 19).

grounded in the nature of kinds. To be more precise, as concerns the laws of nature, he (2006) thinks that

> [t]he supposed entailment of 'For any x, if x is F, then x is G' by 'F-ness necessitates G-ness' is unexplained and mysterious.[64][65] To this I would add the objection that laws do not, in fact, entail constant conjunctions amongst particulars[66] in any case, because laws—apart, perhaps, from certain fundamental physical laws—admit of exceptions which arise from the possibility of interfering factors in the course of nature, an example being the possible deviation of planets from their elliptical orbits as specified by Kepler's laws of planetary motion.[67] Laws, in my view, determine *tendencies* amongst the particulars to which they apply, not their actual behaviour, which is a resultant of many complex interactions implicating a multiplicity of laws. (p. 29)

That is to say, Lowe accepts that nature is non-uniform. In other words, he quite frankly allows for the possibility of exceptional cases in nature. For instance, take the kind `raven` and the law that ravens are black. This does not rule out the possibility that there can be non-black sub-species of the kind raven in nature. Or take the law that 'planets move in elliptical orbits'. It doesn't entail 'every single planet is moving in an elliptical orbit'. Indeed this is clearly not absolutely true, given the gravitational interference between the planets and other disturbing factors. What it entails is only that 'every planet is disposed to move in an elliptical orbit'. Hence, he thinks, if laws are dispositional in character, despite that they cannot provide absolutely certain knowledge about the behavior of kind instances, they are still significantly informative about nature.

---

[64] Lowe (2006) gives a footnote and says, "For this complaint, see Bas van Fraassen, *Laws and Symmetry* (Oxford: Clarendon Press, 1989), ch. 5." (p. 29).

[65] My note: This account is Armstrong's account: N(F, G) entails 'For all x, if Fx then Gx' (where the variable 'x' ranges over particulars).

[66] My note: This account is Humean's account.

[67] Lowe (2006) gives another footnote and specifies, "See again my *Kinds of Being*, ch. 8, and also my 'What is the "Problem of Induction"?', Philosophy 62 (1987), pp. 325–40." (p. 29).

In his opinion, the formulation of inductive inferences as generic statements, which express *laws*[68], rather than universal generalizations is the correct way to formulate them and the observations of the "normal" or “typical” instances of kinds (such a normal raven, a typical planet, etc.) are persuasive enough to *prima facie* believe in the truth of law-like facts about them. In claiming this, he (1987) embraces the principle that the majority among the members of a given kind must belong to the normal or typical members; it would be “incoherent” to assume that this is false (p. 336). I will refer to this as ‘the principle of normality’. And yet, he thinks, one can make predictions or inferences from the laws in a justified way.[69] Hence, the problems regarding laws do not have their source in getting from the particular to the general but rather “[i]n the correct characterization of the particular in general terms” (ibid, p. 338). And he argues that an inductive inference, though deductively not valid, can still be “reasonable” because “we can have good yet non-deductive (defeasible) reasons for believing in specific predictions and laws” (ibid, p. 339). Thus, he claims that the problem of induction would dissolve in this way.

Critique of Lowe’s Intended Solution

One way to question Lowe’s account is as follows: As in Armstrong’s and Ellis’s views, there is *the problem of discovery* for Lowe’s (self-dubbed) “serious essentialism” too: how can we know that there is a kind K? Firstly, kinds are substantial universals. Therefore, as in the case of my evaluation of Armstrong’s

[68] Lowe (2006) specifies, “The form of a law, in the simplest case, is just this, on my view: substantial kind *K* is characterized by *F*ness, or, even more simply, *K* is *F*” (p. 132).

[69] But what if there are some cases, particularly cases among biological species, in which most of the actual examplars of some kind are atpyical? If there are, this would jeopardize Lowe’s claim.

account, the problem of universals applies to Lowe's account too. Secondly, as in the case of my evaluation of Ellis's account, to consider some phenomenon or object to be a member of a natural kind does not make membership in a particular kind certain. In principle, that phenomenon may not be a member of any natural kind at all.

Secondly, as it applies to nomic necessitarianism and scientific essentialism, *the problem of classification of phenomena* applies to Lowe's account too: for any given object or phenomenon, how can we know which kind K it is, essentially? And for any given attribute, how can we know which kind K it instantiates, essentially? He embraces the principle of normality, but what is the criterion to be a "normal" member, say for instance, for a biological kind? Until which mutation should a particular be considered a "normal" member? Until which DNA sequence in a gene is it considered 'normal'? In short, the concept of normality is a tricky concept. As discussed in my evaluation of Ellis's views, the changeability of the set of necessary and sufficient properties for kind membership raises difficulties in determining the existing biological species.

Thirdly, *the problem of individuation of kinds* applies to Lowe's account too, like it applied to Ellis's account: how can we know which attributes are entailed by membership in kind K? Again as discussed in the critique of Ellis's solution, we have argued that these problems pose challenges against the dispositionalist approach to the problem of induction. For Lowe, kinds have a bearing on dispositions. In order to be able to correctly characterize a particular in general terms, we need to have the knowledge of its attributes which informs us about its dispositions. But since we cannot observe all the conditions, we cannot know their dispositions completely.

That is, it seems that contrary to what Lowe thinks, the problem of induction is still a problem.

Alongside these, there is another way to challenge Lowe's position: On Lowe's account of laws, some laws such as fundamental physical laws may admit of no exceptions, yet some do admit. As concerns induction, the fact that there are both strict and non-strict laws creates a difficulty in the following sense: on the one hand, there are epistemically fallible generalizations, and on the other hand, there can be exceptionless generalizations. But, if there are both strict and non-strict laws of nature and all laws have the same ontological ground, that is, there are only attributes featuring kinds, then what makes some laws exceptionless, others not? What is the difference between exceptionless laws and non-exceptionless laws stemming from?

Let us suppose that it is the essences' of things that make some laws strict, the rest non-strict. Would it help us in terms of a dissolution to the problem of induction? Lowe (2008) thinks that all things in nature must have an essence –, as he puts it, a 'what it is' (p. 35).[70] In other words, the essence of something is its identity. The view he defends 'serious essentialism'[71] holds that "essence precedes existence" both ontologically and epistemologically, and "essences are the ground of all metaphysical necessity and possibility" in nature (ibid, p. 35). His conception of the notion of the essence is different from the conception of its contemporaries (for instance, that of Kripke, 1980; Putnam, 1975; Ellis, 2009). Unlike his contemporaries, Lowe does not take the essence of a thing as its internal constitution which can be discovered by empirical investigation. But if something's essence is not

[70] There are two arguments to defend the existence of essences: First argument is the epistemological argument: if nothing would have essence, then it would be impossible to think and talk about things intelligibly. Second argument is that if things do not have essence, then they do not have identity.

[71] According to Vetter (2011), this view falls under the category of 'object essentialism' (p. 774).

its discoverable internal constitution, then what is it? Yet, he is nonetheless positive that we can know the essences of things. He (2008) says,

> To know something's essence is not to be acquainted with some further thing of a special kind, but simply to understand what exactly that thing is. This, indeed, is why knowledge of essence is possible, for it is a product simply of understanding—not of empirical observation, much less of some mysterious kind of quasi-perceptual acquaintance with esoteric entities of any sort. (p. 39)

I find Lowe's conception of our knowledge of essences problematic. Let alone that there are already problems for those who think that kind essence is knowable only by empirical research (as we have seen in Ellis), when Lowe says that the knowledge of essence is a product of understanding, he somehow makes the issue even more complicated. What he means by understanding here can be interpreted as an attempt at offering an epistemological solution. If it is 'understanding' that provides us the knowledge of essences, and if by means of the knowledge of essences, we are able to comprehend the real nature of phenomena, and hence, to determine laws, to identify the properties that feature kinds, and to make inductive inferences and predictions, then was a metaphysical solution required? That is, here we see that Lowe seems to wink at the idea that the problem of induction cannot be dispensed with metaphysics only.

So, with reference to all the points made above, I conclude that, as it stands, Lowe's account can't dissolve the problem of induction.

The pandispositionalist approach to the problem of induction

While dispositional essentialists take the problem of induction as a genuine skeptical problem, pandispositionalist do not agree with them and take it as a pseudo-problem. In *Getting Causes from Powers*, Mumford and Anjum (2011) claim that one need not

assume that there are strict uniformities in nature in many regards. They argue against necessitarianism, to be more specific causal necessitarianism, to which, they say, dispositional essentialism eventually makes a commitment[72]. According to the theory 'causal dispositionalism' they developed, causal powers or dispositions (namely causes) tend toward their manifestations (namely their effects) only – not necessitate or ensure them (pp. 47-85).

A fragile thing tends towards breaking when fallen but it is not necessary that it breaks. Someone who sunbathes tends towards getting skin cancer but it is not necessary that she gets. This is simply because, they say, causal processes of nature are open to the counteractions of other causal factors in a given surrounding. Even if c causes e, there is always the possibility that some other factor could have occurred and intervened in the course of the process. And had it intervened in the process, even if c happened, e did not follow: a soft cushion on the floor is added to the otherwise causally successful situation where a fragile thing would have broken when fallen, and it does not break. A healthy diet or regular exercise is added to the otherwise causally successful situation where someone gets skin cancer when they sunbathe, and they don't get cancer.

Hence, in their opinion, this means that causation does not involve necessity or necessitation. So they (2011) specify, "if there were necessity to be found in causation, then the problem of induction would seem to be dissolved. The future would indeed proceed like the past if it were for all time necessitated what caused what" (p. 82). But mostly this is not the way things are in nature; nature seems to

[72] Mumford and Anjum focus on the accounts given by the new essentialists Bird (2007), Ellis, Harré and Madden (1975), and Shoemaker (1980). Ellis and Harré & Madden are natural kind essentialists. Shoemaker and Harré & Madden apparently commit to causal necessitarianism. Ellis is a bit more flexible than Shoemaker or Harré & Madden. Despite being a causal necessitarian, he thinks that causal processes can be interfered.

lack strict uniformity. Accordingly, they (2010) argue that causal production and causal necessitation (the idea that causes necessitate their effects), are two different things (p. 144; 2011, p. 53, pp. 70-4). For instance, let us take the causal claim that sunbathing causes skin cancer. Sunbathing can lead to skin cancer. If it does, this is called as a causal production. Yet, sometimes sunbathing does not lead to skin cancer (to put it differently, sunbathing does not necessitate skin cancer). That is, it is not the case that sunbathing *always* causes skin cancer. For instance, someone who takes care of her diet and regularly exercise can get away from cancer despite heavily sunbathing. Yet, to think reversely, neither does healthy diet nor exercise *always* cause someone from getting away from cancer. And so, this brings us to the fact that there is always the possibility of interferences and preventions in the causal processes, Mumford and Anjum think that there can be some dispositional general causal claims or truths but not the strict general causal truths.

Hence, Mumford and Anjum (2011) find the problem of induction as a "pseudo-problem" (p. 141) because "the uniformity of nature principle, if it means absolute regularity, is simply false" (p. 142). In their opinion, "The essential truths in question are nothing more than that being *F* (causally) disposes it towards *G*, as an essential part of what it is to be *F*. What is necessitated, therefore, is only that each *F* is disposed towards *G*" (ibid). Consequently, they (2011) claim that

> A solution to the 'problem' of induction was, then, misconceived by the lights of the dispositional theory. There are no, at least need be no, occurrent general causal truths. But there can, nevertheless, be some dispositional general causal claims. Being *F* can dispose toward being *G*, and this does not and need not entail the regularity that $\forall x(Fx \rightarrow Gx)$. Nature may well contain few, if any, causal truths of this general occurrent form, in which case the search for a method that produces such statements as the conclusion of a sound argument is not a goal worth seeking. (p. 143)

As far as I understand from Mumford and Anjum's account, dispositions of things construct a good basis for reliable inductive or predicative inferences we make in daily life or in science only to some degree, not wholly. Furthermore, predictions about phenomena (objects and events) are sometimes unsuccessful for it is always possible that some causally relevant factor is overlooked or just unknown. Consequently, even if there are any general causal truths, these should be understood dispositionally rather than as absolute regularity or necessity.

So, are Mumford and Anjum right about their claim that the problem is a pseudo-problem? Firstly, Mumford and Anjum are wrong about their claim that "if there were necessity to be found in causation, then the problem of induction would seem to be dissolved" (p. 82). As we have seen before, Ellis's approach cannot dispense with inductive skepticism. That is, the problem of induction cannot be solved even if it is anticipated that there is no place for contingency in the workings of nature.

Secondly, Mumford and Anjum's argument for non-uniformity of nature bears resemblance to Lowe's argument for non-uniformity of nature; they all think that there is room for contingency in the workings of nature, natural processes can be interfered. Accordingly, Mumford and Anjum say that although there cannot be strict general causal truths, it is possible to have some dispositional general causal claims or truths. If so, the problem of induction cannot be considered as a pseudo-problem since this time it would concern these dispositional claims. Yet, as we have seen in my evaluation of Ellis's views, there are problems concerning the reliability of general dispositional claims, which arise from the unknowability of conditions. And as we have seen in my evaluation of Lowe's views, problems similar to the problems that concern Ellis's account arise for Lowe's account as well.

Hence, we have arrived at the end of the fourth chapter. As before, let me lay out the ideas of this chapter in the form of a table (Table 4). In the Ellisian kind of world, objects/kinds are active and have essences; essences refer to a unique cluster of causal powers, capacities and propensities; properties are intrinsically powerful and there are both dispositional and categorical properties; dispositionalism does not entail quidditism; the relation between cause and effect properties is metaphysical necessity; the laws of nature are the facts about the essential dispositions of kinds and they are immanent to the world; Ellis thinks that inductive inferences are justifiable and the dispositional essences of natural kinds do the work in the justification; and I argued that there are problems concerning the knowledge of the nature of kinds.

In the Lowean kind of world, objects are active and have essences as in the Ellisian kind of world; we can only say that the essence is the object's identity, comes before its existence and its knowledge is obtained via understanding; any property (attribute) can be predicated either dispositionally or occurrently of an object (where dispositional properties are dispositional predication, categorical properties are occurrent predication); the relation between cause and effect property is only tendency, not necessity; the laws of nature relate to kinds; Lowe thinks that the problem of induction can be dispensed; but I argued that there are problems arising out of his ontological backdrop as well as problems concerning the knowledge of nature of kinds.

In the pandispositional kind of world, objects are active and have no essences – objects are nothing but aggregation of powers; properties are intrinsically powerful, there are only dispositional properties; dispositionalism does not entail quidditism; the relation between cause and effect properties is tendency only; the laws of nature

are the descriptions of how the causal powers of things act and affect each other; pandispositionalists think that the problem of induction is a pseudo-problem; and I think that the problem of induction should concern general dispositional causal claims or truths too.

Table 4 – Humean, Armstrongian, Ellisian, Lowean, and Pandispositional World

World	Humean World	Armstrongian World	Ellisian World	Lowean World	Pandisposi-tional World
Objects	Passive	Passive	Active	Active	Active
Essence	No Essence/ Heacceity	No Essence/ Quiddity	Causal Powers, Capacities, Propensities	Essence precedes existence.	No essence, the concept of essence is trivial.
Quidditism: the independence of property's identity and the nomic/causal roles it play.	Categoricalism entails quidditism	Categoricalism entails quidditism.	Dispositiona-lism doesn't entail quidditism.	Dispositiona-lism doesn't entail quidditism.	Dispositiona-lism doesn't entail quidditism.
Causation: what is the relation between cause and effect property?	Constant Conjunction	Contingent nomic necessity	Metaphysical necessity	Only tendency, no necessity	Only tendency, no necessity
Laws of Nature & Status of Laws	Regularities. Reductionist.	Contingent relations btw universals. Primitive, immanent in the world.	Depending on the essential nature of things, immanent in the world.	Laws relate to kinds. Primitive, immanent in the world.	Laws are descriptions of how the causal powers of things act and affect each other.
Is Induction Justified?	Hume argues that inductive inferences cannot be justified.	Armstrong thinks that induction is rational, justifiable. Natural necessitation relation does the work.	Ellis thinks that inductive inferences are justifiable. The unchangeable essences of natural kinds do the work.	Lowe thinks that inductive inferences are generic statements that express laws. The problem can be dissolved.	The problem of induction is a pseudo-problem.

My view/critique	Humean account of nature encourages inductive skepticism. Nothing hinders objects from acting irregularly or in radically different ways in Humean metaphysic. Regularities may break down at any point in future.	Nomic necessitarian account of nature cannot help us overcome inductive skepticism. Armstrong doesn't help us with the epistemic issue, that is, how we know time-invariant regularities from experience. There are the problem of discovery of universals, the problem of classification of phenomena, the problem of discovery of *N*, the necessitation relation. And Armstrong allows for the possibility of 'cosmic epochs', space-time limited laws in nature's makeup. Objects may act irregularly or in radically different ways. Regularities may break down at any point in future.	Scientific essentialist account of nature, despite being a more sophisticated one, cannot help us overcome inductive skepticism. There are the problem of discovery of kinds, the problem of classification of kinds, and the problem of individuation of kinds. In addition to these, the case of hidden causal powers creates a greater problem. There can be not-yet-manifested causal powers in nature; regularities may break down at some point in future.	Lowean dispositional essentialist account of nature cannot dispense with the problem of induction. There are the problem of discovery of kinds, the problem of classification of kinds, and the problem of individuation of kinds. In addition to these, Lowe winks at the epistemological solution. So, it seems that Lowe's endeavor is insufficient to dissolve the problem.	The problem of induction applies to dispositional general causal claims or truths.

Suggestion for Further Study

I think that dispositionalism provides us a more coherent ontology that addresses the ontological commitments of the special sciences like biology, psychology in addition to those of physics and chemistry than Humeanism or nomic necessitarianism. Therefore, in this short section, I will make some suggestions on this topic for those who might want to take the issue further in future studies.

For dispositionalists laws are entailed by the ascription of power-like properties. The main problem with, for instance Mumford and Anjum's view, is that it cannot explain laws that are not tied to properties of particulars, like conservation laws or any laws that just expresses functional relations between states of closed systems at different times (e.g. quantum mechanics). Let us take conservation laws.

A conservation law states that a particular measurable property of an isolated physical system undergoing a change remains constant in the course of time. For instance, the law of conservation of energy, the first law of thermodynamics, states that the total amount of energy is unchanged in an isolated system even though it may switch between different types of energy. We see that the electric energy in a lamp turns into the light energy and the heat energy but we do not see that it is created or destroyed – the total amount of energy remains constant throughout the process. So, if there are such laws in nature, surely inductive inferences concern them too and an account of induction should include them too. Thus, a dispositionalist should be able to account for them in accordance with his account.

Ellis offers a solution (the world as a kind, the world is a closed and isolated system) (1992; 2001, p. 212; 2002, pp. 95-97), but this seems to me a bit ad hoc. I

believe that this is a problem to worth pursuing for a dispositionalist. So, one can carry out a study on this topic and see how it contributes to dispositionalism in general and its relation with inductive skepticism in particular.

CHAPTER V: CONCLUSION

In this thesis, I delve into the current metaphysical discussions on one of the most vexing problems of philosophy, the problem of induction. I analyze how nature's makeup is captured from different metaphysical views, and what these views entail about the problem of induction. As we have seen, similar problems, such as the problem of discovery, the problem of the classification, and the problem of individuation, arise against different necessitarian views nomic necessitarianism and scientific essentialism. Also, each view faces its own specific problems. Lowean dispositional essentialism, despite not being a necessitarian view, nonetheless encounters the challenges posed by the problem of discovery, the problem of the classification, and the problem of individuation too. Pandispositionalism, another anti-necessitarian view, hasn't dispensed with the problem of induction either. The recent efforts to justify induction haven't settled the issue yet. The closest one to a solution among these metaphysicians seems to be Lowe. Yet, what his argument indicates to us that we cannot overcome the problem departing from empiricism. And this wouldn't surprise Hume.

REFERENCES

Aristotle. (1998). *Metaphysics*. (H. Lawson-Tancred, Trans.). London: Penguin.

Armstrong, D. M. (1978). *A Theory of Universals*. Cambridge: Cambridge University Press.
---. (1983). *What Is a Law of Nature?*. Cambridge: Cambridge University Press.
---. (1989). *A Combinatorial Theory of Possibility*. Cambridge: Cambridge University Press.
---. (1991). What Makes Induction Rational? *Dialogue*, 30, 503–511.
---. (1993). The Identification Problem and the Inference Problem. *Philosophy and Phenomenological Research*, 53, 421–422.
---. (1997). *A World of States of Affairs*. Cambridge: Cambridge University Press.

Armstrong, D.M., Martin, C.B. & Place, U. T. (1996). *Dispositions: A Debate*, London: Routledge.

Beebee, H. (2006). Does anything hold the world together?. *Synthese*, 149, 509-533.

Biffi, G. & Tannahill, D. & McCafferty, J. & Balasubramanian, S. (2013). Quantitative visualization of DNA G-quadruplex structures in human cells. *Nature Chemistry*, 5, 182-186.

Bird, A. (2005). Laws and Essences. *Ratio*, 18, 437–461.
---. (2007). *Nature's Metaphysics: Laws and Properties.* Oxford: Oxford University Press.

Bird, A. & Tobin, E. Natural Kinds. (Winter 2012). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/win2012/entries/natural-kinds

Cartwright, N. (2007). *What makes a capacity a disposition?* In M, Kistler & B. Gnassousou (Eds.), *Dispositions and Causal Powers* (pp. 195-206). Hempshire: Ashgate.

Chakravartty, A. (2007). *A Metaphysics for Scientific Realism: Knowing the Unobservable.* Cambridge: Cambridge University Press.
---. Scientific Realism. (Summer, 2011). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/sum2011/entries/scientific-realism

Choi, S. & Fara, M. (Spring 2012). Dispositions. In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/spr2012/entries/dispositions/

Dretske, F. (1997). Laws of Nature. *Philosophy of Science*, 44, 248–268.

Ellis, B. (1998). An Essentialist Perspective on the Problem of Induction. *Principia*, 2, 103-124

---. (1999). Causal Powers and the Laws of Nature. In H. Sankey (Ed.), *Causation and Laws of Nature*, (pp. 19-34). Dordrecht: Kluwer.
---. (2001). *Scientific Essentialism.* Cambridge: Cambridge University Press.
---. (2002). *The Philosophy of Nature: A Guide to the New Essentialism*. Montreal: McGill-Queen's University Press.
---. (2009). *The Metaphysics of Scientific Realism*. Durham: Acumen Publishing Co.
---. (2010). Causal Powers and Categorical Properties. In A, Marmodoro (Ed.), *The Metaphysics of Powers: Their Grounding and Their Manifestations*, (pp. 133-142). London: Routledge.

Ellis, B. & Lierse, C. (1994). Dispositional Essentialism. *Australasian Journal of Philosophy*, 72, 27–45.

Esfeld, M. (2010). Humean Metaphysics versus a Metaphysics of Powers. In G, Ernst & A, Hüttemann (Eds.), *Time, chance and reduction. Philosophical aspects of statistical mechanics*, (pp. 119–135). Cambridge: Cambridge University Press.

Feldman, R. Naturalized Epistemology. (Summer, 2012). In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/sum2012/entries/epistemology-naturalized

Geach. P. T. (1961). Aquinas. In G. E. M. Anscombe & P. T. Geach (Eds.), *Three Philosophers* (pp. 65-125). Oxford: Blackwell.

Goodman, N. (1955). *Fact, Fiction, & Forecast*, Cambridge, MA: Harvard University Press.

Groff, R. (2012). Whose Powers? Which Agency?. In R, Groff & J, Greco (Eds.), *Powers and Capacities in Philosophy: The New Aristotelianism* (pp. 207-227). New York, NY: Routledge.

Haley, D. (Ed.), (1978). *Marine Mammals*. Seattle, WA: Pacific Search Press

Harré, R. (1970). Powers. *British Journal for the Philosophy of Science*, 21, 81–101.

Harré, R. & Madden, E. H. (1975). *Causal Powers: A Theory of Natural Necessity*. Oxford: Basil Blackwell.

Heil, J. (2003). *From an Ontological Point of View*. Oxford: Clarendon Press.
---. (2005). Dispositions. *Synthese,*144, 343–356.

Heraclitus. (2003). *Fragments. (*B, Haxton. Trans.) (J, Hillman. Ed.) New York: Penguin Classics.

Hume, D. (2000). *A Treatise of Human Nature*. D. F. Norton & M. J. Norton (Eds.). Oxford: Oxford University Press. (Original work published 1739-40)
---. (1975). *Enquiries concerning Human Understanding and concerning the Principles of Morals*. L. A. Selby- Bigge, MA . (Ed.). Oxford: Clarendon Press. (Original work published 1777)

Jacob, P. (Fall 2010). Intentionality. In *The Stanford Encyclopedia of Philosophy* online. Retrieved from http://plato.stanford.edu/archives/fall2010/entries/intentionality

Jacobs, J. D. (2011). Powerful Qualities, Not Pure Powers. *The Monist, 94* (1), 81-102.

Kistler, M. & Gnassousou, B. (Eds.), *Dispositions and Causal Powers.* Hempshire: Ashgate.

Kripke, S. (1980). *Naming and Necessity*. Oxford: Basil Blackwell.

Kornblith, H. (1993). *Inductive Inference and Its Natural Ground.* Cambridge, Mass: MIT Press.

Lewis, D. (1986). *Philosophical Papers II.* Oxford: Oxford University Press.
---. (1994). Humean Supervenience Debugged. *Mind*,103, 473–490.
---. (2009). Ramseyan Humility. In D. B. Mitchell & R, Nola (Eds.), *Conceptual Analysis and Philosophical Naturalism, (*pp. 203–222). Cambridge, Mass.: MIT Press.

Lipton, P. (1991). *Inference to the Best Explanation.* London: Routlegde.

Locke, J. (2004). *An Essay Concerning Human Understanding.* R. Woolhouse (Ed.) London: Penguin Books.

Lowe, E. J. (1987). What *is* the "Problem of Induction?. *Philosophy*, 62, 325–40.
---. (1989). *Kinds of Being: A Study of Individuation, Identity and the Logic of Sortal Terms*. Oxford: Blackwell.
---. (2006). *The Four–Category Ontology: A Metaphysical Foundation for Natural Science*. Oxford: Clarendon Press.
---. (2008). Two Notions of Being: Entity and Essence. *Royal Institute of Philosophy Supplements* 83, (62), 23-48.

Marmodoro, A. (Ed.). (2010). *The Metaphysics of Powers: Their Grounding and Their Manifestations*. London: Routledge.
---. (2011). About the Project. [PowerPoint slides]. Retrieved from http://www.power-structuralism.ox.ac.uk/about_the_project

Martin, C. B. (1997). On the Need for Properties: The Road to Pythagoreanism and Back. *Synthese*, 112, 193–231.

Martin, C. B., & Heil, J. (1999). The Ontological Turn. *Midwest Studies in Philosophy*, 23, 34–60.

Molnar, G. (2003). *Powers: A Study in Metaphysics*. Oxford: Oxford University Press.

Mumford, S. (1998). *Dispositions*. Oxford: Oxford University Press.

---. (2004). *Laws in Nature*. Abingdon: Routledge.

Mumford, S. & Anjum, R. L. A. (2010). *A Powerful Theory of Causation*. In A, Marmodoro (Ed.), *The Metaphysics of Powers: Their Grounding and their Manifestations*, (pp. 143-159).New York: Routledge.

---. (2011). *Getting Causes From Powers.* Oxford University Press: USA.

Popper, K. (1959). *The Logic of Scientific Discovery*. London: Hutchinson & Co.

Putnam, H. (1975). The Meaning of 'Meaning'. *Minnesota Studies in the Philosophy of Science*, 7, 215–271.

Ridgway, S. & Carder, D. &Jeffries, M. & Todd, M. (October 2012). Spontaneous human speech mimicry by a cetacean. *Current Biology*. Vol. 22, Issue 20, R860-R861.

Sankey, H. (1997). Induction and Natural Kinds. *Principia*, 1, 239-254.

Shoemaker, S. (1980). Causality and Properties. In P. van Inwagen (Ed.), *Time and Cause: Essays Presented to Richard Taylor*, (pp. 109–135). Dordrecht: Reidel.

Tooley, M. (1977). The Nature of Laws. *Canadian Journal of Philosophy*, 7, 667–698.

University of Edinburgh. (7 May 2013). Sunshine could benefit health and prolong life, study suggests. *ScienceDaily*, Retrieved May 20, 2013 from http://www.sciencedaily.com/releases/2013/05/130507195807.htm

Vetter, B. (2011). Recent Work: Modality without Possible Worlds. *Analysis* 71 (4), 742-754.

Whittle, A. (2008). A Functionalist Theory of Properties. *Philosophy and Phenomenological Research*, 77, 59–82.