

Ceteris Paribus Laws in Laws of Nature



Omer Fatih Tekin

A dissertation submitted to the University of Bristol in accordance with the requirements for award of the degree of Master of Philosophy in the Faculty of Arts

June, 2015

Word count: 22,512

Department of Philosophy
University of Bristol
Cotham House
Bristol
BS6 6JL

Author's declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.



SIGNED:

DATE: 19.06.2013

ACKNOWLEDGMENTS

First, I would like to thank my dissertation supervisor, Prof. Alexander Bird, for his extraordinary support for my concentration of the work especially the last term, including reading all complete drafts of my dissertation and giving feedbacks. His positive feedbacks and suggestions were invaluable and thanks to the comments, this dissertation is better than it would have been without his help.

Secondly, I also owe large debts of gratitude to the members of my dissertation committee – Dr. Matthew Tugby and Prof. James Ladyman.

Finally, I'd like to thank my family to support me all my life and friends, (Haktan Akcin, Erman Kar, and Ozcan Karadas) and especially, my special thank goes to my fiancée, Bengi, without whose love and support, this thesis would never have been completed.

Abstract

This thesis is divided into four main chapters: the first chapter is concerned with three different views of laws of nature (regularity theory, nomic necessitation and dispositional essentialism). The second chapter will deal with Lewis's best system analysis and how ceteris paribus laws find a place in the system. The third chapter relates to Armstrong's view of nomic necessitation regarding laws with exceptions hold. The final chapter is about Bird's dispositional essentialism and ceteris paribus laws. Ceteris paribus laws can be allowed by this view. As we can see, except for the first section, we are investigating ceteris paribus laws throughout the thesis. The main aim of this thesis, therefore, is very clear: whether ceteris paribus laws can stand in any view.



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Abbreviations

Cp-laws	ceteris paribus laws
(SRT)	Simple Regularity Theory
(BSA)	Best System Analysis
(BBS)	Better Best System
(CA)	Conditional Analysis
GNCs	Generic Non-Material Conditionals



Introduction

Laws of nature play a central role in the philosophy of science; some philosophers have thought that laws of nature are strict laws, and that these strict laws are universal and exceptionless (e.g., Schurz, 2002, p. 351). However, we have seen that there is a vigorous discussion among philosophers of science about what kind of laws have been used, especially in laws of nature of the 'special' sciences, (that is to say, sciences apart from fundamental physics). It can be thought of as an alternative to the strict laws: this is often called the 'ceteris paribus condition' or 'proviso' (Reutlinger, Schurz, & Huttemann, 2011, §. 2.2).

This thesis is divided into four main chapters: the first chapter is concerned with three different views of laws of nature (regularity theory, nomic necessitation and dispositional essentialism). The second chapter will deal with Lewis's best system analysis and how ceteris paribus laws find a place in the system. The third chapter relates to Armstrong's view of nomic necessitation regarding laws with exceptions hold. The final chapter is about Bird's dispositional essentialism and ceteris paribus laws. Ceteris paribus laws can be allowed by this view. As we can see, except for the first section, we are investigating ceteris paribus laws throughout the thesis. The main aim of this thesis, therefore, is very clear: whether ceteris paribus laws can stand in any view.

The aim of the first chapter of this thesis is to outline three different laws of nature: namely, regularity theory, nomic necessitation and finally, dispositional essentialism. In this chapter, I examine what laws generally are, and the relations between instantiations of laws and laws themselves. In this chapter, I investigate the ontological status of the laws. Laws seem as regularity in regularity theory; nomic necessitation theorists try to bring ontological status to the instantiations of laws and laws themselves by relating universals. And finally, dispositional essentialism is totally different from the previous two views. Regularity theory dates back to David Hume, but modern development is due to David Lewis (1973), some other followers being Wright, Beauchamp and Rosenberg. What we can say about regularity theory is that there is no physical necessity in this law of nature. Rather than attributing any physical necessity to the relation between the law and its instance, regularity theorists claim that the law is a collection of the instances, and nothing more, since there is not any kind of ontology

in the law itself, rather than being the totality of instances. There is an alternative view of the laws of nature that goes against regularity theory, namely nomic necessitation. This view is different from laws being mere collections of instances (as in regularity theory). In nomic necessitation, there is a necessary physical connection between instances and laws. David Armstrong (especially 1983) is a proponent of this view. There is a basic problem in the laws of nature regarding how we know the relation between instances of a law and the law itself. Armstrong solved this problem by the introduction of universals. Regularity theory and nomic necessitation theory are both originally Humean. I will introduce this later, but now I just want to mention it, since to be Humean or not can be seen as a criterion of the laws of nature. Armstrong tries to be more categorical to get rid of the Humean characteristic by establishing a connection between the instances of the law and the law itself. However, the theory seems still Humean. The final view in the first part is presented by Bird (1998, 2007). This is called dispositional essentialism. We can see this view as totally anti-Humean, as opposed to the previous two views. In dispositional essentialism, the relation among properties can be essentially dispositional. Here laws are necessary. Recall at this point that, although Armstrong provides a “view of laws that tied laws to the presence of *contingent necessitating relations among universals*” (Psillos, 2002, p. 161; italics original), laws of nature are still contingent in his account. In Bird’s view, however, laws are ultimately necessary. This challenge from the contingent to essential nature of laws has been achieved by the idea that all properties have dispositional essence, as opposed to Armstrong’s view that all properties are categorical.

In the second chapter, I aim to describe Lewis’s best system analysis and whether laws with exceptions accommodate it. David Lewis’s best system analysis of laws of nature asserts that a “regularity is a law *if and only if* it appears as a *theorem* or *axiom* in that true deductive system which achieves a best combination of simplicity and strength” (Lewis, 1973, pp. 72-77). Unlike the laws in simple regularity theory, which just report facts, the basic duty for laws in BSA is to systematize facts. In this account, Lewis holds that genuine laws except accidental generalisations; because of this, he argues that laws of nature are set up only by strict laws. Although Lewis claims that laws of nature consist of strict, exceptionless, and universal laws, some philosophers of science (Schrenk, Callender and Cohen and so on) claim that laws with exceptions can be more useful than strict laws, especially in Lewis’s BSA.

In chapter three, Armstrong's view of nomic necessitation and cp-laws will be examined. Armstrong argues that there are some laws that allows for laws with exception, which he called oaken/defeasible laws. These oaken laws can be seen as farfetched, because they sometimes appear strict, but sometimes exceptional. Moreover, there are some problems, namely the identification and the inference problem. Therefore, this is very controversial matter. I will be investigating and trying to find an answer as to whether such laws occur.

Finally, chapter four is related to dispositional essentialism. I will investigate Bird's view and cp-laws as a positive attribution to the view. In this view, a dispositional law is established by conditional analysis. However, there are some counterexamples, which make the dispositional essentialist laws fail. These are finks and antidotes. Bird argues that this is not a disadvantage of the view; rather, this can be seen as a positive aspect of the dispositionalist view. In this view, there are not only universal laws, but also exclusive cp-laws by means of finks and antidotes. In light of this, ceteris paribus laws are allowed for the dispositional essentialist view. "According to dispositional essentialism, the laws of nature can be explained by taking natural properties to be essentially dispositional" (Bird, 2004, p. 1). Therefore, we will see ceteris paribus laws in Bird's view of dispositional essentialism as a positive aspect.

Now, let me introduce ceteris paribus laws briefly, as these laws will play the central role in my whole thesis. Ceteris paribus laws are of two kinds, and the first is called *comparative*. Here we are concerned with the relation of at least two parameters when other parameters are held steady. In the *exclusive* kind, it is argued that a certain situation occurs when some disturbing factors are eliminated. As an example of the first case, we can talk about an ideal gas law. We say that when we keep the number of molecules and the temperature constant, then the pressure would be inversely proportional to the volume ($PV=nRT$). As an example of the exclusive kind of ceteris paribus laws, we can say that $F=ma$, as long as the friction acting on the body is neglected. Bird is concerned with the second exclusive kind in his dispositionalist understandings of law.

We can give many examples of ceteris paribus (cp) laws, such as ceteris paribus, planets have elliptical orbits (Lakatos, 1970; cf. Schurz, 2002; p. 352), and ceteris paribus, an increase of frustration leads to an increase in aggression (Schurz, 2002, p. 353). Cp-laws can be used in many disciplines; from economics to philosophy.

There are three views of the account of cp-laws as follows;

1. Some philosophers claim that cp laws can be reduced to fundamental physics (e.g. Cartwright, 2002, Pemberton & Cartwright, 2014, Huttemann, 2014);
2. Others such as Schurz (2012) think that ceteris paribus laws are a key concept only for special sciences; and
3. Others (for example Earman and Roberts (1999) and Earman, Roberts, and Smith (2002)), contend that cp laws exist in a proper sense (Unterhuber, 2014, p. 2).

Ceteris paribus laws will be investigated in this thesis, and firstly, I will introduce the different views of laws of nature in general; what the laws are, advantages or disadvantages of the views and so on. After that, I will describe Lewis's best system and cp laws; I will try to find laws with exception in this view. And with the same method, I will explore Armstrong's view of nomic necessitation and Bird's view of dispositional essentialism respectively.

Different Views of Laws of Nature

Introduction

Every morning, the train passes through in front of my house exactly at 8.30 am coming from Easton and leading towards Avon-mouth. This is a regularity for me, because I have seen it every morning since I came to Bristol. On the other hand, when I drop my pencil, it falls down, attracted by the Earth. We have a tendency to generalize the latter kind of instances into a natural law, but do not have any tendency to do so for the first kind of instances. Historically, the latter kind of instances are called regularities, and the former kind of instances are called accidents. So, the basic discussion is about establishing a relationship between accidents, regularities, and laws of nature. More precisely, the question is whether accidents or regularities, (or both, or neither of them), lead us to the laws of nature. Put it in a more philosophical manner, the question is, then, “what is it to be a law?”

The discussion on the ontological position of the laws of nature has been divided into three main parts in the general history of science: Regularity Theory, Nomic Necessitation, and Dispositional Essentialism. Regularity Theory dates back to David Hume, but its modern development is due to David Lewis (1973), some other proponents being Wright, Beauchamp and Rosenberg. The fundamental view in this account is that laws of nature do not possess any physical necessity. Every time I drop my pencil, it accelerates towards the centre of the Earth at a constant acceleration rate. The law here is Newton’s law of free fall (which is a special instance of Newton’s second law and the law of gravitation), and the free fall of the pencil every time I drop it is the instance of these laws. Rather than attributing any physical necessity to the relation between the law and its instance, Regularity Theorists claim that the law is the collection of all these instances, and nothing more than that. Since we do not attribute any kind of ontology to the law itself, rather than being the totality of instances, (in other words, we make the *minimal* claim about the ontological status of the law), Bird calls this view “Minimalism about Laws” (Bird, 1998, p. 27).

An alternative view of the laws of nature that has been introduced as the rival of the regularity view is Nomic Necessitation. *Nomic*, or *nomological* here roughly refers to the empirical ontology of lawhood. The assertion is that there is something more to the laws of nature than

being mere collections of instances. And this surplus or exceeding part is somehow related to ontology of lawhood. Since Regularity Theorists do not attribute any ontology to the laws of nature beyond being mere collection of instances, they do not assert any *necessary* relation between these instances and laws of nature. Rather, the relation is *contingent*. As for the nomic necessity, on the other hand, there is a *necessary* physical connection between instances and laws. This theory has been historically associated with David Armstrong (especially 1983). According to Bird (2007, p. 2), this “view of Armstrong gives laws much more ontological robustness”. It does so because the identity between instances of a law and the law itself in the regularity theory has been avoided by the introduction of *universals*. Our basic problem of finding an intermediate step between instances of a law and the law itself, therefore, is solved by the introduction of universals. Recall here my claim that, although regularity theory’s modern development is due to Lewis, its heritage lies in the work of Hume. Despite prima facie opposition of two theories, the regularity theory and the nomic necessitation theory of Armstrong are both basically Humean (although some argued that Armstrong’s position is semi-Humean, it is still Humean). Some accepted that Armstrong’s manoeuvre has made a step forward within the discussion by establishing a connection between the instances of the law and the law itself. However, they argued, the theory is still Humean and we should take a one more step forward by eliminating this Humeanism totally, in order to make the necessitation about laws of nature a much more plausible position.

Such a position has been introduced by Bird (1998, 2007). This position is called *dispositional essentialism*, which is a totally anti-Humean view. According to Bird, “the principal idea is that this essential relation [the relation between a property and other properties] can be characterised dispositionally” (Bird, 2007, p. 3). In dispositional essentialism, laws are necessary. Recall at this point that, although Armstrong provides a “view of laws that tied laws to the presence of *contingent necessitating relations among universals*” (Psillos, 2002, p. 161; italics original), laws of nature are still contingent in his account. In Bird’s view, however, laws are ultimately necessary. This switch from the contingent nature of laws to the essential nature of them has been achieved by the introduction of the idea that all properties have dispositional essences, as opposed to the categorical monist view of Armstrong that all properties are categorical.

In the remainder of the paper, I will investigate these three views in detail, and argue that Bird's dispositional essentialism provides the best argument to establish the link between an instance of a law and the law itself plus although *ceteris paribus* laws can be used in the other views of laws of nature (regularity theory and nomic necessitation), *ceteris paribus* laws are supplied with the best version in the Bird's dispositional essentialism.

1. Regularity Theory

According to regularity theorists on laws of nature, there is no ontologically physical necessity in laws of nature. We can take this as a fundamental of this account. As I noted in the introduction, every time I drop my pencil, it accelerates towards the centre of the Earth at a constant acceleration rate. This is an example of the law of gravitation and then Newton's second law, and the free fall of the pencil every time I drop it is the instance of this law. In regularity theory we can see only instances as I have given above; it is unnecessary to add any ontological necessity to the relation between the law and its examples. For the proponents of this theory, it can be just a collection of all the instances as a law, and nothing more than that. As a consequence, in regularity theory, laws have no ontological attribution; conversely, they consist of a collection of instances.

Regularity theory can be dated back to Hume, and is supported by Mill (1947 [f.p. 1843]), Ramsey (1978 [f.p. 1928]) and Lewis (1973. 1983. 1986, 1994). In regularity theory, laws can be thought as the determinations of the world, and nothing else. This means that laws just report what is going on in the world. We see instances of this: when I drop my pencil, it falls down and every instance is regular, so we can just pick up these regular instances in this theory. Roughly speaking, laws are identified with regularities in this view. In other words, no ontological status other than being a collection of regular instances is attributed to the laws.

As mentioned in the introduction, Bird calls this view the "minimalism about laws". It can be said that regularity means a true generalisation, which is same as a true inductive conclusion. According to Bird, "one inductive conclusion we might draw is that all emeralds are green, and another is that all colitis patients suffer from anaemia. If these generalisations are true, then it is a fact that each and every emerald is green and that each and every colitis sufferer is anaemic" (Bird, 1998, p. 27).

Now, we can explain the simplest kind of minimalism; regularity theory indicates that there is a similarity between laws and regularity. We can call this view the simple regularity theory (SRT).

a. Simple Regularity Theory (SRT)

Regularity theory claims that the totality of regularities have the necessary and sufficient conditions of lawhood. To generalise, we can formalise laws in the following form:

$$\forall x (Fx \rightarrow Gx)$$

We can think of “F” as the property of “being made of metal”, and “G” as the property of “conducts electricity”. So, we read the above formula as follow: if something is a metal, then it conducts electricity. In regularity theory, the law that “all metals conduct electricity” is solely based on the totality of instances where we observe that a metal regularly conducts electricity. No further ontological status is attributed to laws, other than the totality of instances (metals conducting electricity). This position is called the “Simple Regularity Theory”. On the SRT account, then, a law is just a report of a bunch of observations. In other words, we claim here that laws and regularities are the same.

The formulation of simple regularity theory, then, would be as follows:

SRT: it is a law that Fs are Gs if and only if all Fs are Gs.

I have said earlier that the regularity theory of laws has its roots in the philosophy of Hume. When it is said that it is a law that metals conduct electricity, Humeans mean that there is a regularity in nature according to which when a metal is subject to electricity, it conducts a current. Notice that there is no necessity in this regularity account of laws, since it is a logical possibility that a metal could be subject to electricity and does not conduct a current; also there is nothing in the nature of a metal that makes it the case that, necessarily, it will conduct electricity when subject to a current. However, when we do not establish any *necessity* between particular instances and the law, (in other words, when we assert that the law is just the totality of these instances), we would not be able to differentiate between the laws of nature and accidents, since both are regularities. So, this leads us to think that there should be something more to the laws than mere regularities, if we do not want to reduce laws of

nature to mere accidents. Finally, it can be seen that, even the most naïve simple regularity theorists would intuitively accept that the fact that the train passes through in front of my house exactly at 8.30am every morning *is not* a law, whereas ‘all metals conduct electricity’ *is*. This fact implies one of the most common criticisms against the regularity theory of laws, that not *all regularities are laws*. Since accidental generalizations are not laws, being a regularity is not sufficient for being a law.

The second common argument that has been used to single out the weakness of regularity theory of laws is the idea that *not all laws are regularities*. In other words, being a regularity is not *necessary* for being a law. For instance, there are no-instance, or ideal conditions laws. Newton’s second law of motion asserts that acceleration is produced when a force acts on a mass: the greater the mass, the greater the amount of force needed. Its physical formulation is as follow: $F=ma$. In other words, it is asserted that if the total force acting on an object with a mass “m” is zero, then this object would not accelerate. However, this is just an idealized condition that we cannot find any instance of, since we cannot observe an object with a zero total force acting on it. So, we talk about a law (Newton’s second law of motion), but we do not have any instance of it in the real world. In other words, we have the law without any regularity. Similarly, the ideal gas law can be formalised as follows: $PV = nRT$, where “P” is the pressure, “V” is the volume, “n” is the number of moles, “R” is a constant number, and “T” is the temperature. We can say, for instance, that if we keep pressure (P) and the number of moles (n) unchanged, the volume (V) would be increased or decreased in proportion to the temperature (T). Again, however, there are no such idealized instances in nature where P (and n) is kept unchanged.

Although we claim here that we are talking about a *law* where we haven’t observed an *instance* of it, this ideal gas law gives us information about instances that have not yet been observed. In other words, it seems that such a law would allow us to infer what *would* be the case *if* certain conditions were met. This is the point where Lewis’s counterfactual theory gets into the discussion as a solution to the problems of the simple form of the regularity theory of laws.

b. Counterfactuals

Recall our basic question: “what is the difference between accidental generalization and a law?” We have seen that the simple regularity theory fails to provide any difference. At this point, counterfactuals seem to have potentiality to help us, in the sense that they might be used as a tool to differentiate between when a statement is a law and when it is just an accidental regularity.

A counterfactual has the following form: if it were that A, then it would be that C.

In order to see how the introduction of the concept of counterfactual helps us to differentiate between genuine laws and accidental generalizations, let us start with some examples follows;

Here is the first statement: if the rails of train going from Easton to Avon-mouth had been heated, it would have expanded. However, in the UK, weather generally cannot be very hot in summers. In real condition, the rails are not expand. Therefore, there will be no changes in the properties of rails when unless are not heated. This is related to what would have happened in non-actual worlds.

Here is the second statement: if I had studied hard, I would have passed the exam. This example is also about what would have happened in a possible world. In real world, passing exams when studying hard. On the basis of this generalization, we cannot find nothing. This statement does not based on any laws, this is just an accidental generalization.

In the first example, we can see it is true, since there is a law based on the statement that metals expand when heated. On the other hand, second example seems to be just an accidental generalization.

Here, the counterfactual statement that “Had the rails of train going from Easton to Avon-mount been heated, it would have expanded” does not talk about an instance that we have observed. In other words the statement is not about what actually happened. Rather, it is a statement about what would have happened in a possible world where the rails of train is heated (recall that the rails *is* not heated in the actual world). The basic idea here is that laws support counterfactuals, while accidents do not. So, at a first glance, a counterfactual theory of laws seems to be more plausible and strong enough to show that we should abandon the

minimalist theory. By the introduction of the information about what would have happened in some possible worlds, counterfactual theory seems to provide much more information than the regularity view, where the laws are conceived solely as instances of what actually happens.

However, as Bird rightly points out, “laws support counterfactuals only because counterfactuals implicitly refer to laws. Counterfactuals therefore have nothing to tell us about the analysis of laws” (Bird, 1998, p. 34). Moreover, when we say all Fs are Gs, we say something about Fs and Gs here in our *actual* world. It does not have anything to do with the possible worlds where there are different Fs. This is the reason why counterfactuals do not provide an analysis of laws in Bird’s terms.

c. Best System Account (BSA): Modified Regularity Account

So far we have seen how it is difficult to distinguish between laws and accidentally true generalizations. The Best System Account has been introduced to provide an alternative view for both minimalist and counterfactual theories of regularities. Simple regularity theory faces problems in which there is some generalisation that seem to be a law, or some regularities that is established accidentally. It tries to exclude the accidental generalisation from the account. However, best system analysis can solve the problem of how to distinguish between laws and accidents. It asserts that a “regularity is a law *if and only if* it appears as a *theorem* or *axiom* in that true deductive system which achieves a best combination of simplicity and strength” (Lewis, 1973, p. 72-73).

According to Psillos:

Why simplicity? As Ramsey (1928: 131) noted, although the choice of axioms (and hence of the fundamental laws) may sound arbitrary, the requirement of simplicity will certainly constrain this choice. And why strength? Obviously, because the deductive system should be as informative as possible vis-à-vis the regularities that hold in the world. But simplicity and strength pull in contrary directions. Hence, a balance should be struck. (Psillos, 2002, p. 149).

And the following quote is important: Lewis says,

the virtues of simplicity and strength tend to conflict. Simplicity without strength can be had from pure logic, strength without simplicity from (the deductive closure of) an almanac ... What we value in a deductive system is a properly balanced combination of simplicity and strength –as much of both as truth and our way of balancing permit. (Lewis, 1973, p. 73).

A group of true generalisations can be deductively generated in a various ways. Of these statements, some are simpler than others, whilst some are stronger than others. So one question occurs: how can I choose, as the generalisation consists of the true laws of nature? Lewis answers this question cited by Psillos:

we should take into account all systematizations that achieve a good combination of simplicity and strength, and that we should take the laws of nature to be expressed by the axioms (and theorems) that are common in all these systems. Notice also that, although we do not know everything, we can idealize a bit. We can conceive of an ideal deductive systematization based on the assumption that we know everything. (Psillos, 2002, p. 150).

Unlike the laws in Simple Regularity Theory, which just report facts, the basic duty for laws in Best System Analysis is to systematize facts. In this account, as opposed to the accidents, laws cannot be taken in isolation. Laws are regularities, but not all regularities are laws. Genuine laws here are differentiated from accidental generalizations by being members of a coherent system of regularities, and this is achieved by the simplest and strongest systematization of facts.

There are many advantages of the Best System account, such as those I have mentioned above: it protects the laws from accidental generalisation by using the deductive system that has simplicity and strength. Secondly, we can see that basic laws and derived laws are separated from each other. Consider Kepler's example. Kepler's laws of planetary motion are derived from Newton's law (that is, laws of gravity). There is no opportunity to see this derivation in simple regularity theory, but the best system account allows us to take it nevertheless. Finally, it responds to the counterfactual statements of the theory. We know something about the world and, on the basis of our knowledge about the world, we can say

that these are true counterfactuals. So, the best theory consists of both laws and counterfactuals.

However, this position has some disadvantages as well, the most basic being that “whether or not some regularities are expressed in the best deductive system (or systems) of the world will depend on how this deductive system is *organized*, and on what is allowed to go into it” (Psillos, 2002, p. 152). On the other hand, it is difficult to find an *objective* criterion for what determines that system is simple and strong. Finally, it can be seen that, a system might be a very strong one for one scientist, where it might not for another.

c.1. Trivialization Problem of Lewis’s BSA

In this section, I am going to explain a problem for Lewis’s BSA. This problem leads us to see one of the most important challenge about Lewis’s best system analysis. Let’s see when we try to make the best system be strong, and simple; generally face to this problem which causes us to establish ridiculous arguments.

The best system is the system which has the best balance between strength and simplicity (Lewis, 1999a, p. 234). Moreover, for Lewis, a collection of truths can be a law if and only if best system receive it as an axiom or a theorem (Lewis, 1999a, p. 232). In this context, Lewis does not want to assume that there is just only a single best system in our world. A single best system exists only if nature is kind (Lewis, 1999a, p. 232f).

Truths are competing each other in the best system and there are some winners. In BSA, laws can be seen as the winners among all truths. In this account, there are some truths which are simple and some others are strong. Strong truths contain many information about the world. ‘All balls are red coloured in Bristol’ this statement is simple whereas ‘All balls are coloured are red’ is more informative and stronger. As we can see above, simple truth are often not strong, and strong truth are often not simple. However, this conflict sometimes can be avoided. “The truth that any two objects are attracted to one another, with a force proportional to the product of their any two objects and inversely proportional to the distance between them, is relatively simple, but also quite strong in that it tells us a lot about

the forces between many distinct objects”¹. For Lewis, the laws like this, can be called as simple but strong truths.

Such these laws (simple but strong truths) need to have two qualifications; first, collections of truths, that there is a system which contains simplicity and strength as a measurement and comparison. And second, only generalisations truths, which are in the winning collection, that’s means best system, there is no place in the system for every truth, it opens for just only generalisations. “So even if the best system includes particular facts about the Big Bang or its immediate aftermath, e.g. that the early universe was a low entropy state, those facts are not laws on Lewis’s view”².

If we want the laws be simple, then truths should be measured by the length of their statement in their language. Consider that x is in a world where every truth in this library is true if and only if Fx be true. Therefore, F can be said as a simple and strong, so every F can be seen as a law. However, this logical deduction unavoidably face to trivialisation problem.

We can invert a new predicate F which holds of some object (any object) when some specific regularity F holds. Then $\forall x Fx \leftrightarrow R$.

There is a system which contains that ‘all computers are black coloured’. And a new property is ‘this ball has a new predicate (I shall give it a fake, non-real property in order that it can be understood easily) such as kedi. So in this system, this ball is ‘kedi’ when computers are black coloured. If there were no black coloured computers, balls would not been ‘kedi’. This is simple enough but there is no validity. Because when we put the simplicity and strength as a criteria in the best system, there would something happen like that. So, this absurd example allows us to see the trivialization problem in the best system.

Let me explain it different way;

Imagine that we think that the best system is S , where S contains several laws, e.g.

$$S = \quad \forall x (Fx \rightarrow Gx) \quad +$$

¹ <http://plato.stanford.edu/entries/david-lewis/#5>

² <http://plato.stanford.edu/entries/david-lewis/#5.1>

$$\forall x (Gx \& Hx \rightarrow Px \vee Qx) \quad +$$

$$\forall x (Qx \vee Rx) \quad +$$

.....

Now let us introduce a new property (predicate) Z, which we define like this;

$$Zy \text{ iff } \forall x (Fx \rightarrow Gx) \quad \&$$

$$\forall x (Gx \& Hx \rightarrow Px \vee Qx) \quad \&$$

$$\forall x (Qx \vee Rx) \quad \&$$

.....

Therefore, $\forall x Zy$ is T this is new best system

In Unterhuber's words, "if arbitrary predicates were to be admitted, the predicate Fx would also have to be included, where Fx is true of all and only those space-time points of worlds at that the system $S = \{\forall x Fx\}$ is true. S would then be maximally strong, since it implies all facts in our world. Moreover, S seems to be as simple as any system can be. Thus, such an S, would always come out as the best system, regardless of which matters of facts are obtained (Lewis, 1999b, p. 42)" (Unterhuber, 2014, p. 7).

There is a brief solution from Lewis. "We measure the simplicity of a claim by how easily stateable it is in a language where all predicates denote perfectly natural properties. He notes that this move requires that the natural properties are specified prior to specifying the laws, which means that we cannot reductively specify naturalness in terms of laws"³.

So, these difficulties show that no modification of regularity theory provides a genuine understanding of laws of nature. Therefore, in the next section I will discuss the position of David Armstrong, where laws are described as contingent, but are given a much stronger character by the introduction of nomic necessitation.

³ <http://plato.stanford.edu/entries/david-lewis/#5.1>

2. The Nomic Necessitation Theory

So far, we have seen that we need more than mere contingent regularities for something to be a law. We also seen that, although the counterfactual analysis of Lewis and the Best System Account provides prima facie advantages over simple regularity theory, they have their own problems and cannot establish a satisfactory link between laws and their instances.

The necessitation theory, which was developed by Armstrong (1983), Dretske (1977) and Tooley (1987), is against the regularity theory of laws of nature. This is because in regularity, theory laws are not physically necessary, whereas in necessitation theory, the connection between an instance of a law and the law itself is established by necessitation. The necessitation theory, therefore, puts forward that laws are something more than the just collections of instances.

Here is the formulation of nomic necessitation: it is a law that *Fs* are *Gs* if and only if *Fness* necessitates *Gness*. *Fness* and *Gness* here are universals; hence the necessitation is introduced as the connection between universals. To be more precise, a law can be identified as *relation of necessitation* between two *universals*. Or, a law is a particular *property* that holds of two *general properties* that hold of an *individual* (i.e., a law is a particular *relation*). This particular relation is called *necessitation*.

Therefore, the difference between genuine laws and accidental generalizations has been highlighted by the introduction of universals. Let's remember our famous law, "all metals conduct electricity". Nomic necessitation claims that this law is not the sole expression of the regular succession of two instances (or two event-types). Rather, it says something more than that all metals conduct electricity, in the sense that it explains a relation between two *universals* or properties: the property of being a metal ('metal-hood') is always co-instantiated with the property of being conductive (conductivity), since there is a there is a necessitation relation between these two properties (metal-hood and conductivity) that guaranties the co-instantiation.

So far, so good. The necessitating relation $N(F, G)$ between the universal (or property) of *Fness* and the universal of *Gness* seems to provide a solid basis to differentiate between genuine laws and accidental generalizations. However, in order to understand the nature of

this “N” relation, it is essential to recognize the difference between first order and second order relations. We can describe a first order universal as a predicate of or relation among specific things although a second order universal as a predicate or relation among first order universals. So if we return to our example that “all metals conduct electricity”, *being metal* and *conducting electricity* are first order property of particular things, such as iron. And the second order relation among first order properties of this particular iron, or the relation among *being metal* and *conducting electricity*, is the necessitation involved within the laws.

There are several advantages of this account. Firstly, the introduction of necessitation definitely provides a strategy to differentiate accidental regularities and genuine laws. Although, a regularity does not have to be an instantiation of law, all instantiations of laws are regularities. (Instantiations of laws are formed of only those regularities that are characterized by the necessitation relation). Secondly, the nature of scientific explanation: a considerable number of scientists believe that the main duty of science is to provide *explanation* for observed phenomena. By the introduction of necessitation, an explanation for law-like regularities is provided. The intuition is that the presence of those regularities that are instantiations of laws are explained by necessitation relation: why is my pencil subject to free fall near the Earth with certain acceleration when I drop it? Because my pencil has the first order properties of *having mass* and *being attracted in a gravitational field*; and because there is a second order relation among these first order properties, namely the necessitation involved in the law that “massive objects are attracted in a gravitational field”. So this additional second order property explains this regularity. Thirdly, there is an induction on the basis of this account. In this account, necessitarians claim that there is no chance of being provided with a satisfactory understanding of induction by the SRT and the BSA views. The idea is that the necessitation relation supplies the metaphysical “connectivity” which enables us of causal inductive inferences. It cannot be justified by such causal inductive inference, unless there is allowance for some form of connectivity.

On the other hand, on this account there are several problems, the first being concern about the vague nature of this necessitation relation: what is it? Any definition seems to have a disadvantageous position in terms of distinguishing it from the minimalist and BSA accounts. The objection is that we do not have experience of the universals. Although Armstrong’s position differs from that of the Platonists in the sense that he does not argue for the

existence of universals outside space-time (greenness does not exist independently if there are no green particulars), the nature of necessitation as a universal is still problematic for some. A regularity theorist, for instance could basically argue that nomic necessitation theorist will be able to saying nothing at all due to the fact that the argument of 'Fness necessitates Gness' is the same as the argument of 'there is a law that Fs are Gs'. The second concern is about the epistemological status of this necessitation relation: how do we know it? Necessitation is in principle an unobservable property, since it is a universal. At this point, consider two worlds W_1 and W_2 , which are empirically equal, meaning that both worlds agree on all observable regularities. Necessitarians seem to be forced to claim at this point that these two worlds with common observable regularities might have different laws of nature. Now, the question for the necessitarians is this: if the laws of nature are different in these two worlds, how could we come to know this difference, given that all observable regularities are same? If our only access to laws is through *empirical observations* of regularities in nature, then how could we establish the epistemic basis that allows us to draw the conclusion that W_1 and W_2 are different? Although the nomic necessitation account has been introduced to solve the problems of earlier accounts, such as the minimalist account or BSA, these theories seem to have better plausibility in the face of this epistemic question. For in the BSA account, as long as the standards of simplicity and strength are the same in these two different worlds W_1 and W_2 , they would not be different. In minimalist theory, on the other hand, since the laws are basically identified with regularities, if W_1 and W_2 have the same observable regularities, then *they are the same*.

Moreover, in nomic necessitation theory, identification and inference problems can be faced. The problem is obvious. In nomic necessitation theory, there is a necessitating relation between properties and universals $N(F, G)$, we have no idea what relation is, since there is no explanation. In addition, nothing to say that how the collection of regularity All Fs are Gs establishes. According to Psillos,

Armstrong insists that $N(F, G)$ entails the corresponding (Humean) regularity. All Fs are Gs; but it is not clear at all how this entailment goes if the regularity All Fs are Gs is contained in $N(F, G)$ as the sentence P is contained in the sentence P & Q, then the entailment is obvious. But then there seems to be a mysterious extra Q in $N(F, G)$ over the P (= All Fs are Gs). And we in the dark as to what this might be, and how it ensures that the regularity obtains. (Psillos, 2002, pp. 164-165)

The problems that are identification and inference problems are established by van Fraassen (1989, p. 38-39) that should be faced and solved by any sufficient theory of laws. There is a duty for any account of laws that is explain how to assign laws, and in particular what difference laws from accidental generalisation. Identification problem can be solved by this way. van Fraassen has idea about the solving the inference problem, for van Fraassen, reductive account of laws can solve the inference problem because laws are regularities, but it can fail to sufficiently cope with the identification problem because it is not the issue that the differentiation between laws and accidental generalisation. However, van Fraassen argue that there is no better way in the non-reductive view of laws. It means that it can solve the problem of identification because laws can be identified with necessitation relations among universals –we can obviously see that it is different laws from accidental generalization, but it can fails to solve inference problem because, “even if the so-called necessitating relation among universals is cogent, there is no valid inference from a necessitating relation among universals to the corresponding regularity” (Psillos, 2002, p. 165). The last objection is related to Tooley’s view. Tooley claims that “the fact that universals stand in certain relationships may logically necessitate some corresponding generalisation about particulars, and that when this is case, the generalisation in question expresses a law” (Tooley, 1977, p. 622). As we have seen earlier, there is a nomic relation between Fness and Gness, and the corresponding general statement ‘All Fs are Gs’ are deduced from it. According to van Fraassen, we do actually not know how we can deduce logically this deduction.

Let’s see the Armstrong’s position about the nomic necessitation. Armstrong try to explain the necessitation relation $N(F, G)$ and solve the inference problem. His argument is that

the relation $N(F, G)$ is itself a universal, which is instantiated in the positive instances of laws. Take, for instance, laws such as All ravens are black, All metals expand when heated, All planets move in ellipses and the like. On Armstrong’s view they all have forms of the same type: $N(F, G)$, $N(P, Q)$, $N(R, S)$, and so on. They all fall under the type $N(\Phi, \Psi)$ where Φ and Ψ are second-order variables ranging over first-order universals. So the relation of necessitation $N(\Phi, \Psi)$ is a second-order relation (universal) whose relata are first-order properties (i.e. first-order universals). (Psillos, 2002, p. 166)

Armstrong hold the universal distinguish from the classical forms. For Armstrong universals mean that it can be repeatable and recurring speciality of nature. For example, it can be said that there are two bananas on the table and they are both yellow, it should be meant, at least

for Armstrong, the instantiations of the two particulars (the bananas) have the very same property (yellowness). Yellowness is a repeatable component of things that is to say that different particulars have the instantiations of the very same yellowness.

In Armstrong's position, firstly properties are first-order universals, and secondly, there is a hierarchy of higher-order universals. This is basis on the Armstrong's view. Armstrong argues that it needs to be suggested higher-order properties, relations of first-order properties and relations. According to Armstrong, laws of nature is a higher-order properties, since the main reason is that the relation of necessitation is necessary to be accounted for it. This explanation is a repeatable and recurring speciality of nature, so it is a universal because it provides the main criteria for being a universal. As we have seen before, the relation of necessitation $N(\Phi, \Psi)$ is a recurring component of all laws. Armstrong, therefore, considers, it is a second-order universal. According to Psillos, "Admitting that $N(\Phi, \Psi)$ is a universal, argues Armstrong, can lead us to see how a specific necessitating relation $N(F, G)$ is such that is guarantees that the corresponding regularity All Fs are Gs obtains" (Psillos, 2002, p. 167). So it can be thought that the inference problem can be solved like this.

Alexander Bird (2007) has shown the weakness of the necessitation account of Armstrong by highlighting the contingent characteristic of laws in this necessitarian account. He calls Armstrong's position semi-Humean, since the contingent nature of necessitation in his account does not provide a complete break with Humeanism. Unless the necessitation relation in Armstrong's account is provided on a metaphysical basis, (in other words, unless the contingent nature of the necessitation in his account is replaced by a metaphysical understanding of necessity), his arguments would not be able to provide a better position than the regularity theory. The emphasis, therefore, is on the metaphysical nature of necessity (Bird, 2007, p. 2-3).

3. Dispositional Essentialism

So far, we have seen that there are two main approaches to the nature of laws of nature. One of them is the regularity conception of laws, and the other, the view of nomic necessitation. However, as we will see, there is another account for the laws of nature, called dispositional essentialism, which rejects the two main arguments of the previous accounts. Dispositional essentialism differs from the previous two understandings of the laws of nature in two

fundamental ways. First, laws are thought to be *contingent* on the two previous accounts, whereas *metaphysical necessity* has been introduced by the dispositional account. Second, while properties are thought to be *categorical* in the two previous accounts of laws, in the dispositional account, they have essential nomic or causal powers. In other words, properties in dispositional essentialism are thought to be something nomic, whereas in earlier accounts they have been introduced as having non-nomic (this is what categorical means in that regard) nature.

In the introduction, I said that, while simple regularity theory is perfectly Humean, Armstrong's nomic necessitarian view could be seen as semi-Humean. An explanation of why this is so, I believe, would serve as a starting point to investigate Bird's dispositional account of laws. Hume was a sceptic about causation. When a stone breaks a window, Hume asserted as an empiricist, we cannot *observe*, or *experience* the causal link between the strike of the stone and the breaking glass. Hume concluded, on the basis of his empiricist concerns, which, since we do not experience the causal link itself, we cannot talk about any *metaphysical necessity* between the strike of the stone and the breaking glass. We do inductively conclude that every time the stone strike, the window would be broken. However, this inductive reasoning has been established by mere regularities and it does not imply any metaphysical link between the cause (the strike of the stone) and the effect (the breaking of the window). Recall at this point that the simple regularity theory was arguing that laws are nothing more than the totality of the particular instances of the laws. It should be clear now why simple regularity theory is Humean: in simple regularity theory, we do not establish a metaphysical link between instance of a law and the law itself, just as we do not establish any metaphysical connection between cause and effect in a Humean understanding of causation. As for the semi-Humean nature of Armstrong's position, although Armstrong establishes a link between instance of a law and the law itself by a reference to universals, the metaphysical status of universals makes his position a problematic one. When I say that "iron conducts electricity", the necessitation relation is established between iron's first order properties of "being a metal" and "conducting electricity"; and this relation itself (which is a second order property) is involved in the *law*. So, there seems to be a sort of link established by a reference to universals. This point is problematic since the ontological status of universals itself is subject to some criticisms. Nominalists, for instance, believe that such universals simply do not exist.

In Armstrong's account, these universals are not inhibited outside space-time as is the case in the philosophy of Plato. So, the link between the instance of a law and the law itself is established by a second order property, by a universal, in Armstrong's position, but the vagueness of the metaphysical status of this link prevents us stating that the link between an instance of a law and the law itself is metaphysical. On the other hand, we cannot say that there is no link here, as in the case of simple regularity theory; so Armstrong's position is not as Humean as the simple regularity theory. On the other hand, his position is to some extent still Humean, since the relation between first order properties has not been established in terms of metaphysical necessity.

After the explanation and comparison of the preceding competing views, we can start to examine the dispositional essentialist view of laws of nature.

In dispositional essentialism, as a kind of dispositional realism, unlike the previous views of laws of nature, it can be said that the nature of the fundamental natural properties is at the centre of this view. It is a metaphysical stance that, according to Ellis and Lierse,

"it is realist about the dispositional properties of the fundamental particles and fields and essentialist for two reasons: first, because it holds that these properties are amongst the essential properties of these particles and fields; and second, because it holds that it is essential to the natural processes in which these particles and fields may be involved, that they should be displays of these dispositional properties" (Ellis and Lierse, 1994, p. 39).

In dispositional essentialism, perhaps not all fundamental natural properties can be seen to be held as dispositional. According to Bird's definition, however, dispositional essentialism is the claim that "at least some sparse, fundamental natural properties (and relations) have dispositional essences" (Bird, 2007, p. 45).

A disposition is characterised by its stimulus and response or manifestation. For example, we can use the popular example that objects have the property of being soluble: there is the process of dissolving as the manifestation; and there is the object being put into water as the stimulus. "At a more fundamental level inertial mass can be characterised as the disposition to respond to the stimulus of a force by accelerating in inverse proportion to that mass" (Bird,

2005, p. 354). In this context, it can be thought that there is a counterfactual implicational relation between stimulus and manifestation. Thus, if a soluble object were put into water, then it would dissolve; “if an inertial mass were subjected to a force, then it would accelerate in proportion to that force” (Bird, 2005, p. 354).

To put it another way, the structure of dispositions is established by helping the propositions of conditional form. For instance, glasses always break when they are dropped; this means that glasses are fragile, which is to say that a glass will break, if the glass is subjected to being dropped. “Similarly, to say that this piece of rubber was elastic is to assert a proposition with content close to: had this piece of rubber been moderately stressed, it would have deformed in a non-permanent fashion” (Bird, 2004, p.1).

Dispositional Essentialism can be divided into two separate parts: dispositional monism, and the mixed view (some properties are categorical and others are dispositional). There are many philosophers who defend this view taking a stronger position such as Popper 1959; Harré 1970; Harré and Madden 1975; Shoemaker 1980; Mumford 2004; Bird 2005, 2007; Chakravartty 2007; Whittle 2008. Dispositional monism or causal theory of properties or simply named dispositionalism asserts that the fundamental properties have dispositional essences, whereas the mixed view claims that some properties have dispositional essences and some do not. According to Bird, “dispositional essentialism is the claim that at least some fundamental natural properties have dispositional essences” (Bird, 2007, p. 45). Therefore we hold dispositional monism instead of the mixed view because it has metaphysical necessity and essential nomic or causal powers.

In dispositional essentialism, it can be thought that the essence of a property P is characterised by nomic and causal powers essentially. The nomic power of P is a sentence that symbolises the totality of the real meaning of the theory. The causal power of P, on the other hand, is its causes and effects potentially. Thus, properties are implied the following identity condition by dispositionalism: properties P and Q can be the same as each other if and only if they play the same nomic and causal powers. It is important because a property P which has the nomic and causal powers identifies “how its instances are disposed to act or

react under various circumstances”. Therefore, on dispositionalism, any property (that is P) gives its instances with the same disposition⁴.

Let’s start introducing the conditional analysis of disposition. It is the central form of the dispositional essentialist view of laws of nature.

A conditional analysis of a disposition might be formulated as follow:

$$(CA) \quad D_{(S, M)} x \leftrightarrow Sx \square \rightarrow Mx.$$

Here, ‘ $D_{(S, M)} x$ ’ stands for the statement that ‘x is disposed to yield M in response to stimulus S’, and ‘ $\square \rightarrow$ ’ formulated the subjunctive/counterfactual conditional, so that ‘ $Sx \square \rightarrow Mx$ ’ abbreviates ‘if x were S it would be M’.

It can be deduced from (CA) that $(Dx \ \& \ Sx) \rightarrow Mx$ is always true. There is a universal truth, $\forall x ((Dx \ \& \ Sx) \rightarrow Mx)$ when we take ‘x’ as a general variable. So it can be seen that the universal truth follows (CA). In dispositional account of laws, we can say that, all laws can be identified by this.

(CA) is metaphysically necessary because it characterises the nature of the property D and is analysis of the dispositional concept ‘D’, since the dispositional nature of properties is held as essential by the dispositionalist. As a result of this, it can be seen that the dispositional law statement $\forall x ((Dx \ \& \ Sx) \rightarrow Mx)$ can be seen as necessary.

So, we can understand that the dispositional law contains both dispositional essentialism and (CA).

This account of laws of nature suffers from the objection that CA is false. In order to understand what this objection actually amounts to, let’s first see what finks and antidotes are. “A finkish disposition is one which is caused to cease to exist by its own stimulus” (Bird, 2005, p.358). So a finkish disposition is changed by its own stimulus. In the case on an *antidote*, on the other hand, the disposition itself is left unchanged but it “alters the

⁴ <http://plato.stanford.edu/entries/dispositions/#CatDisLawNat>

environmental conditions that are required to permit the disposition to yield its characteristic manifestation” (Bird, 2005, p. 359).

Let’s examine finkishness in more detail. There are some dispositions such as fragility, solubility, flammability, and so on. A finkish disposition is one of the counterexamples to conditional analysis. Consider an object that has the disposition of fragility. When we involve it in a chemical reaction, the fragile disposition can change positively or negatively. An object, for instance, when we make it cool suddenly, may become fragile and the fragility of disposition may be lost by being heated. So for example, x is fragile, for each object x , if x is dropped, x would break. When we heat the object quickly enough, the object loses its fragility. Imagine a mechanism that is able to heat or cool an object very quickly when it is dropped or struck. When the object loses its fragility quickly enough, the dropping will not cause it to break. Although it was dropped, it did not break; however, at the time of dropping, the object was fragile. So we have a counterexample to conditional analysis. Bird says,

“The object a has the disposition D , i.e., Da (a is disposed to break when struck). We also have Sa (a was struck), but we also have $\neg Ma$ (a did not break); hence we have $\neg (Sa \rightarrow Ma)$ ” (Bird, 2005, p. 358).

In addition, the reverse of this finkishness may be displayed. Consider an object that is not disposed to be fragile. If it is cooled fast enough, then the act of dropping makes it fragile. So if it is dropped, it would break. However, at the time of dropping the object is not fragile i.e. $\neg Da$. Hence, $(Sa \rightarrow Ma)$.

After the explanation of finkishness, now we can introduce further counterexamples to conditional analysis, which we describe as antidote. ‘Antidote’ can be used to describe environmental interference with provisional causal events that are counted from a disposition’s stimulus s to manifestation m . It is obvious in Bird’s example:

a poison requires not only its own chemical or biological constitution to cause illness; it also requires the participation of the victim’s body. On ingesting a poison that would normally cause illness, a person may take an antidote that interferes with the metabolic pathways the poison would otherwise have exploited, preventing the poison from doing harm. (Bird, 2005, p. 358).

This situation is different from the fink situation. Because the characteristic properties of the poison were not changed, unlike in finkishness (i.e. something fragile was made non-fragile), and the constitution of the poison is still robust. Therefore, an antidote to a disposition is that the poison is still disposed to cause illness when ingested.

Conclusion

The discussion of the ontological position of the laws of nature has been divided into three main views: Regularity Theory, Nomic Necessitation, and Dispositional Essentialism. The fundamental view in Regularity Theory is that laws of nature does not possess any physical necessity. Roughly, a regularity means here a true generalisation, which is the same as a true inductive conclusion. Regularity theory claims that the totality of regularities have the necessary and sufficient conditions of lawhood. In this account, the law that “all metals conduct electricity” is solely based on the totality of instances where we observe that a metal regularly conducts electricity. No further ontological status is attributed to laws, other than the totality of instances (metals conducting electricity).

Notice that there is no necessity in this regularity account of laws since it is a logical possibility that a metal could be subject to electricity and not conduct it, and also there is nothing in the nature of a metal that makes it the case that, necessarily, it will conduct electricity when it is subject to a current. However, when we do not establish any *necessity* between particular instances and the law, in other words, when we assert that the law is just a totality of these instances, then we would not be able to differentiate the laws of nature and accidents, since both are regularities. So, it leads us to think that there should be something more to the laws than mere regularities, if we do not want to reduce laws of nature to mere accidents. This fact implies one of the most common criticisms against the regularity theory of laws, that not *all regularities are laws*. Since accidental generalizations are not laws, being a regularity is not sufficient for being a law. The second common argument that has been used to single out the weakness of regularity theory of laws is the idea that *not all laws are regularities*. In other words, being a regularity is not *necessary* for being a law. For instance, there are no-instance, or ideal conditions laws. Although we are talking about a *law* where we have not observed an *instance* of it, it still allows us to infer what *would* be the case *if* certain conditions were met.

This is the point at which Lewis's counterfactual theory gets into the discussion as a solution to the problems of the simple form of the regularity theory of laws.

The basic idea here is that laws support counterfactuals, while accidents do not. By the introduction of information about what would have happened in some possible worlds, counterfactual theory seems to provide much more information than the regularity view, where the laws are conceived as sole instances of what actually happens.

The Best System Account, on the other hand, has been introduced to provide an alternative view for both minimalist and counterfactual theories of regularities. The basic duty for laws in BSA is to systematize facts. In this account, as opposed to the accidents, laws cannot be taken in isolation. Laws are regularities but not all regularities are laws. Genuine laws here are differentiated from accidental generalizations by being a member of a coherent system of regularities, and this is achieved by the simplest and strongest systematization of facts.

We can say as a disadvantage of Lewis's BSA is that there is no enough explanation for laws, here we can see just laws are regularities and nothing more. It can be seen that the regularities, but they are not accidental generalisations, are laws in Lewis' BSA are located in a best system by the simplicity and strength of truths. It seems to go further step from the simple regularity theory because it is different from accidental generalisation. However, there can be happened ridiculous truths in BSA because of the criteria that are simplicity and strength and when we establish a system it causes to have a new best system. This is another disadvantage called trivialization problem in Lewis's BSA.

The nomic necessitation theory, which was developed by Armstrong, Dretske and Tooley, is against the regularity theory of laws of nature. This is because, laws are just regularities, there is no physical necessary in regularity theory. On the other hand, in necessitation theory, both the instance of law and law itself is established by the connection of necessitation. The necessitation theory, therefore, bring forward that laws are something more than a collection of regularities.

In this account, thanks to the introduction of universals, the difference between genuine laws and accidental generalizations has been foregrounded. Recall at this point that our famous law, "all metals conduct electricity". According to nomic necessitation theorists, this law cannot be a sole expression of the regular progression of two instances (or two event-types).

Rather, for the nomic necessitation theorists, the law says something more than that all metals conduct electricity, in the sense that it describes a relation between two universals or properties: the property of being a metal (metal-hood) is always co-instantiated with the property of being conductive (conductivity), because the necessary relation between these two properties (metal-hood and conductivity) guarantees the co-instantiation.

Another advantage of this account is linked to the concept of scientific explanation. An explanation for law-like regularities can be provided by the introduction of necessitation. The instinct is that the existence of those regularities that are instantiations of laws are expressed by the necessitation relation.

A disadvantage of nomic necessitation view is the criticism that we do not have any knowledge about the universals. Armstrong's position for the universals is not the same as the Platonists in the sense that Armstrong do not want to claim that the existence of universals are outside space-time (there is no existence of redness independently when red particulars do not have). However, there are still some problems for the nature of necessitation as a universal according to some philosophers. A regularity theorist, for instance, could essentially argue that nomic necessitation theorists will really be saying nothing at all due to the fact that there is no difference between the argument of 'Fness necessitates Gness' and 'there is a law that Fs are Gs'.

The third (and the most important view for me) view is dispositional essentialism. The view differs from the two previous understanding of the laws of nature in two fundamental ways. First, laws are thought to be *contingent* on the two previous accounts, whereas *metaphysical necessity* has been introduced by the dispositional account. Second, while properties are thought to be *categorical* in the two previous accounts of laws, in the dispositional account, they have essential nomic or causal powers.

Dispositional essentialism can be described as a kind of dispositional realism which initially focuses on the nature of the fundamental natural properties. Dispositional properties are related to the fundamental particles and fields. In dispositional essentialism, for Bird, "at least some sparse, fundamental natural properties (and relations) have dispositional essences" (Bird, 2007, p. 45).

A disposition is established with its stimulus and manifestation. Let's take a disposition such as fragility: there are glasses that have fragile. When we drop a glass on the ground, it break.

In this process, we can see the dropping as a stimulus; and the breaking as a manifestation. So glasses are fragile. It can be said that the structure of dispositions, therefore, is established by helping the propositions of conditional form.

In dispositional essentialism, the essence of properties are established by nomic and causal powers essentially. The causal power is related to its causes and effects potentially and the nomic power is related to the real meaning of the theory. Properties are implied by dispositionalism such that P and Q could be identical each other when they have the same powers (causal and nomic). So, properties empower their instances with the same disposition. Conditional analysis is very important proposition for dispositional essentialism, since thanks to the (CA), dispositional arguments can be established. Suppose that x possesses the disposition to M when S iff x is disposed to M when S. it means let's take famous example, fragility. $X \text{ is fragile} \leftrightarrow \text{if } x \text{ were dropped, } x \text{ would break.}$

We can see from (CA) that $(Dx \ \& \ Sx) \rightarrow Mx$ is always true. If it is taken 'x' as a general variable, $\forall x ((Dx \ \& \ Sx) \rightarrow Mx)$ will be a universal truth. Universal truths arise from (CA) as we have seen earlier, and then we can say that all laws in dispositional account of laws of nature can be generated by like this.

Therefore, (CA) is metaphysically necessary, since it is related to the nature of the properties and is analysis of the dispositional concept 'D'. For the dispositionalists, the dispositional nature of properties are essential. As a result of this, the dispositional statement $\forall x ((Dx \ \& \ Sx) \rightarrow Mx)$ is metaphysically necessary.

According to many philosophers, conditional analysis is false, and this situation makes the dispositional essentialist account of laws fails, since the account of laws exists itself with the (CA). "A finkish disposition is one which is caused to cease to exist by its own stimulus" (Bird, 2005, p.358). So a finkish disposition is changed by its own stimulus. In the case on an *antidote*, on the other hand, the disposition itself is left unchanged but it "alters the environmental conditions that are required to permit the disposition to yield its characteristic manifestation" (Bird, 2005, p. 359). Finks and antidotes, therefore, makes the (CA) false but in this point *ceteris paribus* laws take the control and these laws can help us to hold (CA). This seems to be negative aspect of this account, but actually it is an advantage for sophisticated dispositionalist view, since it allows us to open a new field of interest which would be the

main subject of this thesis, and how laws with exceptions (that is to say, *ceteris paribus* laws) hold in the different kinds of views of laws of nature would be the central claim in my thesis.



David Lewis's Best System Analysis and CP Laws

Chapter 1 outlined three major theories of laws of nature, such as regularity theory, nomic necessitation analysis and dispositional essentialist view. In this chapter, I aim to explore Lewis's best system analysis and how it can accommodate laws with exceptions. Let's start with a brief introduction to the best system analysis of David Lewis.

David Lewis's best system analysis of laws of nature basically asserts that a "regularity is a law *if and only if* it appears as a *theorem* or *axiom* in that true deductive system which achieves a best combination of simplicity and strength" (Lewis, 1973, pp. 72-77). Unlike the laws in simple regularity theory, which just report facts, the basic duty for laws in BSA is to systematize facts. In this account, as opposed to accidents, laws cannot be taken in isolation. Laws are regularities but not all regularities are laws. Genuine laws here are differentiated from accidental generalizations by being a member of a coherent competing system of regularities, and this is achieved by the simplest and strongest systematization of facts.

In this context, we can give three examples for possible competing deductive systems. First, an enormous lookup-table: the instantiated properties are listed in this system. This would take a beating because it would be very strong, but not simple. Second, there could be a single line like "all electrons have unit charge" (Schrenk, 2006, p. 2). This is very simple, but not strong. There is no chance to win; when we would take a beating in any competition. Finally, "we could have present-day physics" (Schrenk, 2006, p. 2). This is important because this system seems to be reasonably robust, with a combination of all the relevant properties: simplicity, strength, and fit or balance. Moreover, it can take a new position by doing some simpler, stronger and that better fits reorganisation. "In any case, note that Lewis operates from the view point of an omniscient being" (Schrenk, 2006, p. 2): "if we knew everything" (Lewis, 1973, p. 73). So, it can be seen that physics in the future is likely to come close to the real laws, of course at best (Schrenk, 2006, p. 2).

In Lewis's analysis, winning systems' axioms or theorems are allowed to be laws. There would be no obstacle for the laws of particular sciences such as chemistry, biology, geology, medical sciences etc. in the best system analysis of Lewis.

In this section, I will show that whether Lewisian best system analysis of lawhood allows laws with exceptions. First, I will explain generics and universals and how reconstructing cp laws by generics occurs.

Reconstructing CP Laws by GNCs

We can start with a comparison between cp laws and strict laws in the BSA by using Generics and Universals. These concepts provide the laws' reconstruction, meaning that strict laws patterned by universals depend on classical logic, "whereas cp laws formalized by Generic Non-Material Conditionals (GNCs) are based on Delgrande's (1998) non-monotonic possible worlds semantics for generics" (Unterhuber, 2014, p. 3). Here are examples for universal and generic statements:

Generics

(1a) Trees bloom.

(2a) Poplar trees cannot bloom.

Universals

(1b) All trees bloom.

(2b) All poplar trees cannot bloom⁵.

As we can see from the examples above, reconstructed cp laws and generics have some features that might be thought efficient such as Delgrande's, like that cp laws describe regularities and exceptions can be allowed (Pelletier & Asher, 1997, p. 1128f).

Let's start with the logical form of GNCs. GNCs can be formulated as follows: where $\Box \rightarrow x$ binds the variable x in both the antecedent $\alpha[x]$ and consequent formula $\beta[x]$ (Delgrande, 1998, p. 116).⁶

(GNC) $\alpha[x] \Box \rightarrow x \beta[x]$

"Formalism, such as GNCs, have been designed to model inferences of agents with incomplete knowledge" (Unterhuber, 2014, p. 11; e.g. Delgrande, 1998, p. 122; cf. Brewka, 1991, p. 2f). We can call these formalism as non-monotonic, because defeasible inferences can occur in such formalism.

⁵ The formalization of the example taken from Unterhuber. (Unterhuber, 2014, p. 3).

⁶ The syntactic form of GNCs is the same as that of Schurz's (2002) nomic laws (p. 364f).

I explain in more detail: here I want to use Unterhuber's formula, but the example is mine: Suppose that Tx and Bx stand for 'x is a tree' and 'x can bloom,' respectively. If ' Tx ' also abbreviates 'x is a poplar', then we can display (1a) and (2a) by the following formulae"⁷:

$$(1a^*) \quad Tx \Box \rightarrow x Bx$$

$$(2a^*) \quad Tx \Box \rightarrow x \neg Bx$$

Let's give an example: the tree that has been grown by me in my garden and I call it the King of Trees. Consider that (1a) is an argument that about trees and (2a) comes to believe that the King of Trees is a tree. As a consequence, it seems to be justified to infer that the King of Trees can bloom. However, if there is a belief that the King of Trees is a poplar, then the previous inference should be retracted, and the situation could be summed up as the King of Trees cannot bloom.⁸ Here, the inference that the King of Trees can bloom was only defeasibly valid (Unterhuber, 2014, p. 11).

For example, if an agent only learns that the King of Trees is tree, that agent can infer from (1a*) and (2a*) that the King of Trees can bloom, due to (1a*).

For instance, if we learn that the King of Trees is a poplar (and thus a tree), (2a*) wins over (1a*) and we can infer that the King of Trees cannot bloom (Unterhuber, 2014, p. 12).

I want to explain why GNCs can be included in BSA in more detail. We can know, thanks to the GNCs, which properties should be seen as exceptional and which as normal in a BSA. This distinction is important, as the following two systems might compete with each other, if we do not draw out this distinction:

System S:

$$(3) \quad Fx \Box \rightarrow x Gx$$

$$(4) \quad Fx \& Hx \Box \rightarrow x \neg Gx$$

System S':

$$(3') \quad Fx \Box \rightarrow x \neg Gx$$

$$(4') \quad Fx \& \neg Hx \Box \rightarrow x Gx^9$$

⁷ The formula taken from Unterhuber, but the examples are mine.

⁸ This interpretation concurs with Pearl's (1988, p. 475) all-I-know interpretation of generic conditionals (Unterhuber & Schurz, 2013, pp. 14-16).

⁹ These formulas taken from Unterhuber's paper (Unterhuber, 2014, p. 14).

It can be seen easily that, there is an equality between these systems S and S', and they seem strong; and thus, they point out the same regularity.

In system S, the exceptional part is seen in, H although it is $\neg H$ which can be seen as exceptional in the case of S'. It can be seen that "it is quite counter-intuitive to regard both systems as laws of nature" (Unterhuber, 2014, p. 14).

In order to solve this problem as an effective solution, those properties that are seen almost always all space-time points as described in the BSA should be specified as more normal. According to Unterhuber,

"for example, if there are more space-time points which have the properties (i) F, G, and not H than (ii) F, H, and not G, and not G, one counts (3) and (4) as law candidates rather than (3') and (4'); analogously for (3') and (4') if the frequency pattern is reversed." (Unterhuber, 2014, p. 14)

There are some advantages, such as the following: inferences which are fundamental on GNCs, as identified by the BSA seem reliable during a case that though to be real more than exceptional ones. In the BSA GNCs can be matched each other, such as (1a*) and (2a*). After that, one inferences can be seen justifiably that the King of Trees can bloom, given that there is only one knowledge about the King of Trees is that the King of Trees is a poplar. As a result of this, we can deduced that the King of Tress can bloom than it cannot, by the basement of our assumptions. (Unterhuber, 2014, p. 15)

Laws with Exception in Lewis's Best System Analysis

After the general introduction of the best system analysis of Lewis, and reconstructed cp laws by generics, we can turn to the relation between BSA and Ceteris Paribus laws (cp laws). First of all, I would like to say that Lewis seems not to support cp laws in his account:

Few would deny that laws of nature, whatever else they may be, are at least exceptionless regularities. (Lewis, 1986, p. xi)

Admittedly, we do speak of defeasible laws, laws with exceptions, and so forth. But these, I take it, are rough-and-ready approximations to the real laws. There [sic!] real laws have no exceptions, and never had any chance of having any. (Lewis, 1986, p. 125)

As we can see, Lewis's theory seems not to allow for fundamental laws with exceptions. But, there are some, especially non-fundamental laws, such as biology or chemistry, which are *ceteris paribus* laws; that is to say, laws that suffer from exceptions, and so they need to proviso clauses.

These proviso clauses, which have the truth, unfortunately, make a fuss: many philosophers argue that a statement such as "All Fs are Gs, *ceteris paribus*" cannot make good sense. "Such a phrase, so they say, is either tautologous ('All Fs are Gs, unless not') or stands for a proposition ('All Fs which are also ... are Gs', the gap in which we are unable to close). A theory to tell us how to deal with these challenges is needed" (Schrenk, 2008, p. 4).

We can find various views when examining Lewis's theory of counterfactual conditionals. In that theory, there are possible worlds, and these possible worlds are similar to each other. However, for Lewis, laws of nature in similarity considerations do not have special status. Consider two worlds with the same laws everyone has accepted; there should be a necessary condition for worlds i.e., worlds try to share laws in order to be evaluated as similar (Schrenk, 2008, pp. 4-5).

I could, if I wished, incorporate [a] special status of laws into my theory imposing the following constraint on the system of spheres: [...] whenever the laws prevailing at I are violated at a world k but not at a world j, j is closer than k to i. This would mean that any violating of the laws of I, however slight, would outweigh any amount of difference from I in respect of particular states of affairs. I have not chosen to impose any such constraint (Lewis, 1973, pp. 72-73).

We can infer from the above quotation that it provides us with an opportunity that loses the hardness of laws. It is not enough that, in order to allow for laws with exceptions, we need to investigate more;

the violated laws are where they are violated. [...] I am using 'miracle' [i.e., violation of law, MAS] to express a relation between different worlds. A miracle at w₁, relative to w₀, is a violation at w₁ of the laws of w₀. The laws of w₁ itself, if such there be, do not enter into it (Lewis, 1986, pp. 44-45).

When we want to explore laws at w_0 itself, we still need a violation. A starting point can be similar to the following:

A localized violation is not the most serious sort of difference of law. The violated deterministic law has presumably not been replaced by a contrary law. Indeed, a version of the violated law, complicated and weakened by a clause to permit the one exception, may still be simple and strong enough to survive as a law (Lewis, 1973, p. 75).

Let's explain in more detail: consider a possible world (w), a miniature one with a suitable strong best system, which it is described as S . It has only "ten universally quantified statements (F s are G s; all H s are J s; etc.)" (Schrenk, 2006, p. 4). That miniature world's history can be identified by these statements with their primary conditions. Now, consider another world, which is very similar and denoted by w^* . The difference between w and w^* is that an F is not a G at a "tiny space-time point $\langle x_0, y_0, z_0, t_0 \rangle$ " (Schrenk, 2006, p. 4), although the other billions of F instances are all G instances. For Schrenk,

Is not it almost certain that in world w^* no other system but S^* is the robustly better system where S^* differs from S of w only in that the universally quantified F -law is altered to $\forall u (Fu \wedge \neg @ \langle z_0, y_0, z_0, t_0 \rangle u \supset Gu)?$ ($\neg @ \langle x_0, y_0, z_0, t_0 \rangle u = \text{def object } u \text{ is not where the "small, localized, inconspicuous miracle" happens}$). It is neither there are draws between S^* and other systems merely because of this minor exception. (Schrenk, 2006, p. 4)

It is very obvious that the above examples depend on the violation's situation. Violation is temporally and spatially restricted because of this; we can see from Schrenk's paper that

the loss of simplicity, strength and fit we have to accept when we "complicate and weaken" the law by a clause does not affect the robustly best position of the system that includes that law. (Schrenk, 2006, p. 4)

However, such exceptions have a greater effect on laws in a supposed best system, or the system is the less likely to be the best at the more extended the space-time where violations happen.

After Schrenk's view of Lewis's best system analysis, it would be better to briefly introduce Braddon-Mitchell's view of best system analysis, as compared with Schrenk's view.

In Braddon-Mitchell's paper 'Lossy Laws', he asserts that there are some laws with exceptions in a derivative of Lewis's best system analysis of laws of nature. Braddon-Mitchell prefers enrolling the laws as $\forall u (Fu \supset Gu)$ even if there is an exception at (x, y, z, t) . On this point, it seems that Braddon-Mitchell disagrees with Schrenk. Schrenk's view is $\forall u (Fu \wedge \neg @ (x, y, z, t) u \supset Gu)$. However, these arguments for the setting up of exceptions look very like each other. Let's have a brief look at Braddon-Mitchell's view in his own words:

Rather than start with systems that tell only the truth, we start with systems that tell *mostly* the truth. Not any system that tells a few lies will be admitted of course; the justification for the lies has to be that there are generalisations included which hold for the most part, but because they fail sometimes errors are introduced –the law says all Fs are Gs, but the occasional F is not and for no apparent reason. We of course reject any such system that fares no better in terms of simplicity and power than ones which tell only the truth, but leave open the possibility that the one which best trades off these desiderata may be one which includes powerful unifying regularities to which, as a matter of fact, there are exceptions, and which thus violates the accuracy desideratum of telling nothing but the truth (Braddon-Mitchell, 2001, p. 266).

Note that a false law is just one which makes a false generalisation. It is still a law just so long as the generalisation is part of the system which best trades off power, simplicity and accuracy. It is not the old distinction between mere lawlike generalisations, and the laws (Braddon-Mitchell, 2001, p. 267).

If the problem was just ascribed to Lewis then it is obviously clear that Schrenk's view would be more simple. Lewis says, "a version of the violated law may still be simple and strong enough to survive as a law" (Lewis, 1973, p. 75). Schrenk's view of laws is derived from Lewis, in the light of this quote, and expresses a similar meaning to Braddon-Mitchell. So Schrenk says, "laws statements are complicated and weakened by such a close" (Schrenk, 2007, p. 93). Moreover, we can see that there is a conflict between Lewis and Braddon-Mitchell. Braddon-Mitchell takes the position with lying laws against Lewis's position that a best system "must be entirely true" (Lewis, 1983, p. 41). Lying laws make us consider laws statements, in which at least one might be true. It means that "It is a law that..." should simply mean "it is the case that ..." (Schrenk, 2007, p. 93).

However, Braddon-Mitchell's view has a good point for recording law. His "All Fs are Gs" is definitely a law which cannot stand eligible at the index: "No sophistic twist can be made like in the case of my $\forall u (Fu \wedge \neg @ (x, y, z, t) u \supset Gu)$ which is syntactically strict, and gappy only when seen from the perspective of "the classes of lawful and of outlawed events" (Lewis, 1979, p. 55)" (Schrenk, 2007, p. 93).

Conclusion

In conclusion, we examined the Lewis's theory of lawhood in BSA and whether laws with exceptions are allowed. Firstly, Lewis does not accept fundamental or non-fundamental laws with exceptions in BSA. However, Callender and Cohen claim that "Better Best System does not require that aspirants to the title of lawhood should be universal and exceptionless. An incomplete generalization may be sufficiently simpler than any complete one, and thereby gain entry into the Best System" (Callender & Cohen, 2010 p. 441). In this context, It can be said that Callender and Cohen (2010) and Schrenk (2007, 2008) are happy with cp-laws in a BSA. Schrenk (2007, 2008) puts forward a reconstruction of cp-laws in a BSA. For Schrenk (Lewis agrees), facts have fundamental features in the BSA. I agree with Lewis and understand that cp-laws are not crucial for Lewis's analysis of BSA; some others like Unterhuber, Callender and Cohen believe that cp-laws perform better than other laws (strict laws).

Armstrong's Nomic Necessitation View and CP Laws

I aim to show in this paper that how oaken/defeasible laws (that are laws with exception) are established in Armstrong's nomic necessitation. In order to show this, firstly I need to briefly recall general nomic necessitation, and explain some problems such as identification and inference problem. After that, I will introduce oaken/defeasible laws, which are our main interest.

Armstrong's nomic necessitation view can be formulated as follows:

It is a law that *Fs* are *Gs* if and only if *Fness* necessitates *Gness*. *Fness* and *Gness* here are universals; hence, the necessitation is presented as the relation between universals. To be more precise, a law can be classified as *relation of necessitation* between two *universals*. Or, a law is a particular *property* that holds of two *general properties* that hold of an *individual* (i.e., a law is a particular *relation*).

Therefore, thanks to the introduction of universals, the difference between genuine laws and accidental generalizations has been clarified. Let us consider our famous law "all metals conduct electricity". For nomic necessitation theorists, this law is not simply a representation of the regular succession of two kinds of instances. Rather, it says something more than that all metals conduct electricity, in the sense that it invokes a necessitation relation between two *universals* or properties: the property of being a metal (metal-hood) is always co-instantiated with the property of being conductive (conductivity), since there is a necessitation relation between these two properties (between metal-hood and conductivity) that guarantees the co-instantiation.

In order to provide a strict basis for the difference between genuine laws and accidental generalizations, we need to have the necessitation relation $N(F, G)$ between the universal (or property) of *Fness* and the universal (or property) of *Gness*. However, it is essential to identify the difference between first order and second order relations, since the nature of this 'N' relation plays a central role in Armstrong's view of nomic necessitation. We can describe a first order universal as a property of (or relation among) specific things, while a second order universal is a property of or relation among first order universals. So, if we return to our example that "all metals conduct electricity", *being metal* and *conducting electricity* are first

order properties of particular things, such as iron. And the second order relation among first order properties of this particular iron, or the relation between *being metal* and *conducting electricity*, is the necessitation involved in the laws.

The problem of accidental regularities can be rejected on Armstrong's nomic necessitation view. It cannot be said that regularity is an ontological element of law. Conversely, it can be seen that a second order relation between first order universals is an ontological element. In this sense, we can call this relation 'nomic necessitation.' In order to be able to identify the split between laws and accidental regularities, most philosophers claim that a law is set up with regular generalisations plus some *X*. For Lewis, as we have seen earlier, such a law contains *X* which occurs in a deductive system that explains the world in the light of the simplest, strongest, and best fitting perfectly natural properties. For Armstrong, on the other hand, tries to find some regularities that have occurred at a fundamental level: '*Fs are Gs*' is a law if and only if the universal *F* stands in the nomic necessitation relation to the universal *G*. The formula would be as follows: $N(F, G)$. Indeed, Armstrong wants to mention the second order i.e., state of affairs, $N(F, G)$, the law. According to Armstrong, the regularity $\forall x (Fx \supset Gx)$ is set up as a consequence of $N(F, G)$.

As we have seen before, nomic necessitation analysis has some difficulties, which illuminate the nature of exceptional laws. There are two particular difficulties that attract our attention; van Fraassen criticised Armstrong after he had published his theory for the first time in *What is a Law of Nature?* (Armstrong, 1983) and focused on the identification problem and the inference problem (cf. van Fraassen, 1989, p. 96ff; see Armstrong, 1997, p. 228). Armstrong tries to solve these problems in his later work *A World of States of Affairs* (Armstrong, 1997). It is useful to briefly describe van Fraassen's problems before considering Armstrong's answer.

In the identification problem, the question is to find what kind of relation between universals nomic necessity is; in the inference problem, the main question here is how $N(F, G)$ entails $\forall x (Fx \supset Gx)$. First, van Fraassen asks this question: "what information does the statement that one property necessitates another give us about what happens [...]?" (van Fraassen, 1989, p. 96; see Armstrong, 1997, pp. 227-228).

It seems that the identification problem is meaningless according to Armstrong's later book. In fact, in his previous publication, which van Fraassen reviews, Armstrong had not yet proposed any solution for the problem, so that van Fraassen seemed to be right. However, in his later work, he proposes a solution: "The Identification problem is solved via our direct awareness, in certain favourable cases, of causation in the token case" (Armstrong, 1997, p. 228).

The second difficulty, the inference problem, is much harder to examine. There are four responses from Armstrong suggested to us as solution:

When one particular state of affairs brings about another, then the pattern instantiated, one state-of-affairs type bringing about a further state-of-affairs type according to some pattern, is a 'direct' relation between the state-of-affairs types involved, a relation that is the causality instantiated in the situation (Armstrong, 1997, p. 228).

According to Armstrong, when we explain his words, we can suppose that: F is universal and G is universal as well and so is N. N may be seen as a second order universal, establishing a relation between first order universals. What we suppose when we suppose that *Fs are Gs is a law* is that it is 'a second-order state of affairs' that N holds between F and G (cf. Armstrong, 1997, pp. 226-227). Take it that the universal or state of affairs type F is instantiated; in this case N (F, G) holds. However, the instantiation of N (F, G) in the F is itself a matter of causality. Hence, universal G has an instances as well. There is a causal relation between the F and the G. And as a consequence, $\forall x (Fx \supset Gx)$. Therefore, $\forall x (Fx \supset Gx)$ is supplied due to N (F, G) and "this would be seem to solve the inference problem" (Armstrong, 1997, p. 228).

In other words, there is a relation between two universals and it requires the corresponding generalisation, but we cannot consider the opposite entailment. $N(F, G) \Rightarrow \forall x (Fx \supset Gx)$. The problem is obviously related to what N actually is. We have seen that the problem gives us more information about N. It cannot be thought that N is in a different position from the relation that holds between F and G if the regularity $\forall x (Fx \supset Gx)$ is deduced from the strongest, simplest system.

This is the crucial step. If we learn something about laws with exceptions, here is the key point. Replacing a solution brings us to laws with exceptions.

So far so good. The laws with exceptions can be seen as an oaken laws or a defeasible laws in Armstrong's view of nomic necessitation. Here, we will firstly explain what Armstrong means by 'oaken' or 'defeasible laws', in his theory of lawhood, and then whether laws with exceptions can exist in Armstrong's theory. Now, we can start to explore the first of these, which is oaken laws.

Oaken Laws

I want to start with a quotation from Armstrong, on what the oaken laws (what Armstrong calls defeasible laws in his later papers) and iron laws are. There is a distinction between "oaken laws" and "iron laws" for Armstrong: generally speaking $N(F, G)$ is an iron law if there are no physically possible interferences: $N(F, G)$ is an oaken law if there is possible interference. According to Armstrong, the formulation of oaken laws is as follows:

$N(F, G)$ is an oaken law, then all that is entailed is that for *all x where interfering conditions are absent*, if x is F, then x is G. (Armstrong, 1983, p. 149).

We can see that this distinction, Armstrong has drawn it, seems to be ad hoc. There is not any property of the law itself in the foundations of the distinction in the form in which Armstrong presents it. For Kistler, "Armstrong's criterion for establishing it is the accidental fact that, until now no exception has yet appeared" (Kistler, 2006, p. 118). Armstrong's distinction might not appear to be involved the laws themselves; rather it seems to focus on the instantiations which have accidental properties in the absence of reasons that consist of the laws, save the existence of any interfering factors.

There is an argument of Armstrong that tries to provide a suggestion for resisting this objection: he thinks that oaken laws, have a signature of exceptional circumstances, but these circumstances are typically not applicable. For this argument, law can be formulated as follows:

It is a law that Fs are Gs , except where Fs are Hs , are Js , and Ks ... and so on for an *infinite* set of distinct properties (Armstrong, 1983, p. 28, italics Armstrong's).

On the one hand, the law holds in the realist sense; on the other hand, the fundamental law statement. Suppose a law is oaken: according to Armstrong, it has a comprehensive schedule of the conditions, that the conditions are necessary for its practicality, something that would actually be impossible for its clear explanation. This argument, however, can be seen as problematic, because the explanation of the origin of exceptions has not yet been given. “Conceived in Armstrong’s way, oaken laws turn out in the end to be iron laws” (Kistler, 2006, p. 118). An example of an oaken law is “the relation of nomic necessitation between being material body and continuing in the present state of motion or rest” (Lange, 2000, p. 313). This is one of Armstrong’s examples for oaken laws, because it does not entail that all bodies proceed in their present state of motion or rest; otherwise, there would be something wrong. For example, for Armstrong, “Newton’s First Laws is a conservation law, and conservation laws are oaken laws” (Armstrong, 1983, p. 148). Armstrong claims that even an oaken law is connected with a regularity, but in this sense, the regularity is not corresponding to the universals directly forming in the nomic necessitation relation that comprises the laws. Newton’s first law is related to regularity, that all material bodies are not forced to proceed in their present state of motion or rest. Here, oaken laws can be based on Armstrong’s view of what can create a universal. The example deduced from Newton’s first law, is about an isolated systems: energy is conserved. The systems are determined by the energy of the system at a certain time, but there is the same energy in the system at a later time. (Armstrong, 1983, p. 148). However, for Armstrong, Newton’s First Law can be seen as an iron law, so long as it is of infinite length. According to Armstrong:

the vital point to remember is that the relation of necessitation present in each instantiation of the law involves only the actual universals involved. If negative universals are excluded as necessitating factors, then the absence of factors capable of interfering with the necessitation is not a factor in the necessitation. (Armstrong, 1983, p. 149)

Defeasible laws, in Armstrong’s view, are questionable; in this view defeasible laws cause some unacceptable circumstances to occur. Next I want to introduce some interpretations of these situations. I would like to start with a quotation from Armstrong:

We can, though, distinguish between two types of law. If $F \rightarrow G$ (with some probability) is a law, and if it is empirically possible (nomically possible) that there is a universal $F \& H$, and if in these circumstances the probability of an outcome of type G is altered, then $F \rightarrow G$ by itself is a *defeasible* law. [...] It seems to be always possible that for any antecedent of a law there exists such an H . But it may not be empirically possible. If it is not empirically possible, then the law may be called an iron law (Armstrong, 1997, p. 231).

This should be explained in more detail, to help us interpret whether defeasible laws are allowed in Armstrong's view. Firstly, keep in mind that the phrase "with some probability" is related to the connection $F \rightarrow G$, not to "is a law"; that is to say, there might be a probabilistic law between $F \rightarrow G$ which means that G takes place with a certain probability if F is the case (Schrenk, 2007, p. 106).

When we try to learn whether there are defeasible (oaken) laws in Armstrong's view and how they work, it is easier for us to find answers if we ask the following question (Schrenk's question):

"Now, how exactly do we have to imagine what happens in cases where an α is both F and H and, as a result, the causation of G is prevented?" (Schrenk, 2007, p. 106)

Three possible answers can be given as responses to this questions, but not are equally good. These answers given for defeasible laws cause unsatisfying metaphysical consequences.

First, it can be said that a further higher order law occurs; that is to say, in any situations in which the interfering universal, H , is instantiated, the law $N(F, G)$ ceases to hold. That is the following can be laws: $N(F, G)$ and $N(F \& H, \text{not-}N(F, G))$. This interpretation seems unnatural, since it is unacceptable that

the obtaining of a contingent spatio-temporal first order state of affairs should cause a non-spatial, non-temporal second order state of affairs to come to an end. Worse, the lapse of $C(F, G)$ would have to be a local matter: while the α is not caused to be G other objects which are F (and F alone) should still obey the law.

Yet, how could a non-spatial, non-temporal relation between universals cease to hold at a particular place? The question alone has the air of a category mistake. Therefore, I do not consider interpretation (a) any further. (Schrenk, 2007, p. 107)

Second, another possible way out for Armstrong to respond in this way: any situations in which a first order universal $F \wedge H$ acquires $N(F, G)$ will, even though it can be still seen as a second order universal, not be seen as singular causation (that is to say, F is not causing G). This interpretation seems unnatural as well. The complexity here is how the instantiation of $N(F, G)$ can be managed to prevent the acquisition of a contingent spatio-temporal first order universal ($F \wedge H$). Moreover, when it is allowed that it is possible, then it should be thought that “the power of first order states of affairs like $F \wedge H$ to prevent $C(F, G)$ from instantiating is law governed itself” (Schrenk, 2007, p. 107). As we can see, this is another awkward kind of law. This makes us confused and creates further questions.

Finally, the last interpretation is as follows: we have a law $N(F, G)$ and in this sense there is also another law like $N(F \wedge H, \neg G)$. So, “if α is both F and H , it is caused to be G (by being F) and it is caused to be $\neg G$ (by being $F \wedge H$)” (Schrenk, 2007, p. 107). This is an indefensible interpretation again. Armstrong does not want to allow negative universals such as $\neg G$; therefore, it is not acceptable that the law is $N(F \wedge H, \neg G)$ in the first place; moreover the paradox would be indispensable, even if $\neg G$ happened in Armstrong’s ontology of universals: “ α simply cannot *be caused* to be both G and $\neg G$ for it cannot *be* both G and $\neg G$ ” (Schrenk, 2007, p. 107). It can be said that being caused is a proper verb, which means that if we say that if something is caused to be G , that actually means it is G ; the reverse position is the same. If something is not G , it absolutely has not been caused to be G . “I think that we should deny that these are cases of causation [...] no relation exists without its full complement of terms” (Armstrong, 1997, p. 75).

Conclusion

In this section, I evaluated the general knowledge of nomic necessitation, identification and inference problems and oaken/defeasible laws (laws with exceptions) respectively in Armstrong’s view of nomic necessitation. The conception of oaken or defeasible laws (Armstrong offers these as laws with exceptions) can be seen as metaphysically controversial.

That is to say, we cannot find clearly that the laws have exceptions. Armstrong calls the laws with exceptions oaken or defeasible laws, but this is not straightforward. Sometimes a special group of so-called oaken (defeasible) laws can be seen as strict (iron) laws.

In light of this, it can be seen clearly that there are some objectionable consequences in the nomic necessitation of Armstrong's view of laws of nature. First, in this view, the difference between iron laws and oaken laws has disappeared. Because of this disappearance, Armstrong has to accept a conceptual criterion established from the characteristic properties of the laws themselves that makes a distinction between iron laws and oaken laws. Rather, the distinction is drawn from the contingent circumstances between laws that hold in exceptional circumstances and laws that do not actually hold in exceptional circumstances even though they can. However, it is unlikely to be possible that such accidental differences draw a distinction between two fundamental kinds of laws.

The metaphysics of oaken (defeasible) laws in Armstrong nomic necessitation view is in a poor state, as we have expressed three possible interpretations, all of which seem unsuccessful. So, when we ask whether laws with exceptions can be allowed into Armstrong's view, we have not able to find a place for those laws.

Bird's Dispositional Essentialist View and CP Laws

In this section, I am going to express how the ceteris paribus laws can be established positively in the view of Bird's dispositional essentialism. I explained Bird's dispositional essentialist view in the first section; I will now recall it briefly, and then examine the ceteris paribus laws.

There is a very close relation between dispositions and propositions of a conditional form. Windows are broken when something is thrown at them; this means that this window is breakable, which is to say that it would break, if the window is subjected to something heavy being thrown. "Similarly, to say that this piece of rubber was elastic is to assert a proposition with content close to: had this piece of rubber been moderately stressed, it would have deformed in a non-permanent fashion" (Bird, 2004, p. 1). So, as I said before, dispositions and subjunctive and counterfactual conditionals have a very close relationship. When we agree with this view, it can be formulated as follows:

$$(CA) \quad Dx \leftrightarrow Sx \square \rightarrow Mx$$

Normally (CA) is a biconditional (i.e. right to left direction and left to right direction of the biconditional), but in order to introduce exceptional laws in dispositional essentialism, I only focus on the left to right direction.

"(CA $\rightarrow$) Where D is a dispositional property with characteristic stimulus S and manifestation M:

If x has the disposition D, then if it were x to undergo stimulus S, it would yield manifestation M" (Bird, 2004, pp. 1-2).

There is agreement among many philosophers about that (CA) is false. Bird agrees with this, but argues that this is an advantage for a sophisticated dispositionalist view. By forming an analogy between the counterexamples to the conditional analysis and disturbing factors in the exclusive kind of ceteris paribus laws, we can provide an understanding of natural laws that establishes the metaphysical link between instances of a law and the law itself. The main argument in his account is that "to the extent that dispositions deviate from the conditional analysis, laws deviate from being strict, exceptionless laws and are instead ceteris paribus laws" (Bird, 2005, p. 354).

The central argument of Bird is that “the disturbing factors that are required to be absent are precisely the sorts of factor that provide counterexamples (finks and antidotes) to the conditional analysis” (Bird, 2005, p. 359). In this way, we are able to argue that despite (CA) being false due to some counter examples, we can still argue for the dispositional conception of laws, just in the way we are able to argue that *ceteris paribus* laws are said to hold in the absence of some disturbing factors.

So, Bird thinks that by forming an analogy between the counterexamples to the conditional analysis and disturbing factors in the exclusive kind of *ceteris paribus* laws, we can provide an understanding of natural laws that establishes the link between instances of a law and the law itself.

So far so good. As we have seen earlier, there is a relation between dispositions and conditionals. Here is a classical example: a glass has the property of fragility and will break if sharply thrown to the ground. However, sometimes an exceptional situation can occur. The property of disposition cannot be matched with a suitable simple (subjunctive or counterfactual) conditional. It can be seen that the phenomena of finks and antidotes demonstrate that there may be a disposition without the suitable conditional. “According to dispositional essentialism, the laws of nature can be explained by taking natural properties to be essentially dispositional” (Bird, 2004, p. 1). Moreover, *ceteris paribus* laws can be explained by the existence of finks and antidotes. So this should be understood as meaning that, thanks to the finks and antidotes, the account can be broadened, and tell us much more. Consequently, we will see how *ceteris paribus* laws are allowed by the existence of finks and antidotes in Bird’s dispositional essentialist view.

It can be seen that, due to some exceptions, the simple conditional analysis of disposition is false. As we have seen briefly above, Bird has shown that “(CA $\rightarrow$) fails as (part of) an analysis of dispositional locutions. There are two kinds of exception that lead to the failure of (CA $\rightarrow$): finks and antidotes” (Bird, 2004, p. 2).

In this section, therefore, I am trying to analyse Bird’s view of the dispositional essentialism and how this view allows for the *ceteris paribus* laws. In order to allow full understanding, I first need to explain finkish disposition.

Finkish dispositions

In Bird's view of dispositional essentialism, finkish disposition plays a central role in the objection to conditional analysis. There are two characteristic dispositional properties and we must note these if we are to know how they work. Firstly, a dispositional manifestation takes time:

"The poison ingested must interact with the victim's metabolism before it causes illness. The irascible man may be swift to anger but not literally instantaneously. A nuclear pile may be disposed to melt down if the boron control rods are removed, but the meltdown occurs only once the chain reaction has generated enough heat." (Bird, 2007, p. 25)

Consider another example: Salt certainly dissolves when it is put into any liquid, after a sufficiently long time. Salt has the disposition of being soluble, but it takes time to dissolve. Salt may be disposed to dissolve if the liquid is suitable for dissolving the salt. Secondly, there are some such dispositionals which are gained or lost:

"Some food may become infected with the bacterium *Clostridium botulinum* and thereby become poisonous. It can lose that disposition by cooking or irradiation. A person's moods change and they can become irascible having previously been placid and vice-versa." (Bird, 2007, p. 25)

Due to the time delay, finkish dispositions can occur. A disposition has the opportunity to go out of existence and so stop the manifestation process during the time delay between stimulus and manifestation. Let's think that there is an X possessed finkish disposition D to occur manifestation M in reply to stimulus S, if X is subjected to stimulus S to lose D before M happen.

Suppose, to use Martin's example, that an electro-fink is a device that can make an electric wire live or dead. Plus, it also identifies "whether the wire is being touched by a conductor" (Bird, 2007, p. 25). It can be held that 'live' means "disposed to conduct a current when touched by a conductor" (Bird, 2007, p. 25). Suppose that, the wire is live. However, if the wire were touched by a conductor, the electro-fink would cause it to become dead and it would not conduct a current.

Let us take another example: whenever a fragile glass is struck, there are some things that change quickly in the microstructure of the glass so that it loses the property of fragility. As can be seen from such cases, a dispositional object without the suitable conditional can exist, that is $(CA \rightarrow)$ is false. Moreover, finkishness can show us that,

the reverse implication in (CA) is false. In such a case the disposition D is absent, but its characteristic stimulus brings it into existence, and consequently brings its characteristic manifestation into existence. Hence, at some particular time the proposition 'x has D ' may be false; nonetheless the proposition 'were x to undergo S , it would yield manifestation M ' is true. (Bird, 2004, p. 3)

After the explanation of finkish disposition, now we can introduce how antidotes have a role in Bird's view.

Antidotes

As we have seen, finkishness arises owing to fact that the disposition loses its causal basis in suitable cases. For instance, the wire is disconnected from generator by the electro-fink; when a fragile glass is struck, there may be some changes in the microstructure of the glass and this makes it non-fragile. But David Lewis claims that disposition would manifest if no causal basis remains for a long enough time. So, for Lewis, finkishness might not exist when faced with such a case. Consequently, $(CA \rightarrow)$ can be recovered by adding an environmental condition:

$(CA \rightarrow)$ Where D is a dispositional property with characteristic stimulus S and manifestation M :

If x has the disposition D then if x were to undergo stimulus S while retaining the causal basis of D for a sufficiently long time it would yield manifestation M . (Bird, 2004, p. 3)

Imagine that the window has been preserved by a magician. For Lewis, it is obviously clear that, in such a case, if the window is thrown to the ground and the causal basis remains live for a long time, it would break.

Let's start with what an antidote is for Bird. What Bird calls an "antidote" is an intervention in a sequence of causal events, which temporally occur between stimulus s and manifestation m . There is a difference between finks and antidotes. Finks make the object's disposition fail

by altering its inner structure. Schrenk says, "Bird's antidotes, however, leave the disposed object intact" (Schrenk, 2010, p. 2).

Let's take Bird's example of a nuclear pile: "A nuclear pile which is above critical mass (s, the stimulus) has a disposition to chain-react catastrophically (r, the response)" (Bird, 1998, p. 229). However, an antidote, here is a fail-safe mechanism is joined to the pile. "The mechanism allows boron moderating rods to penetrate the pile by absorbing the radiation" (Bird, 1998, p. 229). Therefore, the nuclear pile will not indicate the disposition's response r, although it is above critical mass (stimulus s) and the intrinsic structure of the nuclear pile has not been replaced (that it is disposed to chain-react).

Consider another example: cowards run away when in danger. This is dispositional conditional analysis. It can be formulated like this: x is being cowardly if, faced with danger, x runs away. Let's examine this in more detail. This is the condition that such a disposition occurs when that condition is supplied. In a normal condition, every time they are in danger, cowards escape when in a dangerous situation. But sometimes they cannot move. Some changes in their psychology may occur and they stand still like rabbits. Although rabbits are still afraid, they cannot move, when car lights dazzle their eyes in the dark. Like the rabbits, cowards can sometimes freeze when they face danger, when at other times they may have run away. This is an example of an antidote. In this example, disposition is being a coward and stimulus is any danger and manifestation is escape. Therefore, it can be seen that disposition fails because of the some changes in manifestation.

Bird concludes: "The existence of the causal basis plus stimulus will never be enough to guarantee the required response nor, if the response comes into being, that it came about in the right way" (Bird, 1998. p. 233).

Finally, it can be seen how exceptions to $(CA \rightarrow)$ might occur. We can hold that X possesses the disposition D to give manifestation M in response to stimulus S. It works in normal situations, if x is disposed to M when S iff x has a disposition. Two fundamental reasons hold the dispositional laws be a live. First, causal basis, and second, environmental conditions. If either cannot be found, an exception to $(CA \rightarrow)$ occurs. The disposition suffers from a fink when the first reason is absent; if the second reason is absent, an antidote makes the

disposition fail. Sometimes there can be a misunderstanding about whether an exception is a fink or an antidote. Let's take Bird's example, "an irascible man is disposed to get angry at small provocations" (Bird, 2004, p. 4). The irascible man does not want to be angry suddenly and tries to prevent himself from responding to his irascibility. On a normal occasion, when he be exposed to irritation, he can become angry gradually. However, as he becomes angry, he tries to control himself and does not become angry. This is a very complicated situation, since we really do not know whether it is a fink or an antidote. Bird gives an extreme answer: "as soon as he receives a stimulus that he knows will rouse him to anger, he takes a fast-acting drug that changes his mood to one of placidity." (Bird, 2004, p. 4). It can be said that there would be a fink in his irascibility, because the neurophysiological principle of his irascibility can be changed by the drug. On the other hand, it can be said that this is an antidote in his irascibility, because he exerts self-control by (say) biting his tongue. He is still irascible during the stimulation, but he prevents the usual manifestation of that irascibility.

What we have done up until now in section 4 is to introduce laws with exception –finks and antidotes– in the context of Bird's dispositional essentialist view. Now, I am going to discuss the general meaning of *ceteris paribus* clauses in Bird's view.

Ceteris Paribus

Some philosophers argue that laws are just universal generalisations. There are no laws with exceptions and, all laws are strict. If this were true, a dispositional view of laws would be lost and, the counterexamples to (CA) would not work in this view. However, fortunately, not all laws are clearly exceptionless: we know that many laws are *ceteris paribus* laws. *Ceteris paribus* laws can be divided into two: comparative cp-laws and exclusive cp-laws. When we hold constant at least two parameters, and there can be an option to change the other parameters, this means comparative cp-law. So, for instance, "the pressure of a gas is inversely proportional to the volume it occupies, so long as its temperature and other variables are maintained constant" (Bird, 2005, p. 359). The other kind of cp-laws –exclusive cp-law– will be real if certain disturbing factors are absent. Consequently, to give a famous example, if there are no destabilising factors, such as the gravitational pull of other planets, planets can travel in ellipses. These laws are much more important than the exclusive cp-laws.

Exclusive cp-laws are likely to be more important than comparative cp-laws, since these cp-laws can be seen as observations of dispositions and the interfering factors are definitely the kinds of factors that allow counterexamples (that is to say, finks and antidotes) to the conditional analysis. Thanks to the exclusive cp-laws, it can be concluded that the dispositional conception of laws has not failed; it is still live, in spite of the counterexamples to (CA). After that, dispositional account of laws can be seen as clearer and improved with exclusive cp-laws are used by this view. At the same time, the view has universal laws which are not supposed to finks and antidotes as well. These universal laws are different from exclusive cp-laws.

We are not interested in whether such dispositions and laws exist in this paper, but think that there is no any kind of these dispositions and laws, in such occasion we can see that the dispositional account of laws that experience finks and antidotes have the ideal relationship between dispositions and laws. Suppose that there is a disposition of which it can be said that “where there is a disposition D then the conditional $S \rightarrow M$ holds, so long as finks and antidotes are absent. This generates the following law: $\langle \forall x ((Dx \ \& \ Sx) \rightarrow Mx) \rangle$, so long as D ’s finks and antidotes are absent”, which is clearly an exclusive cp-law” (Bird, 2005, p. 360).

Think of a case in which dispositions have finks and antidotes that promote exclusive cp-laws. For example, planets travel in ellipses around the Sun. As can be seen easily, to travel in an ellipse around the Sun can be taken as the disposition of the planet. Because the stimulus (experiencing the Sun’s gravity) is permanent we should expect the manifestation (travelling in an ellipse) to be permanent too. Infact this manifestation is manifested for the most part. However, there are environmental factors: that is to say, antidotes, that contaminate the disposition. In this sense, we can describe an antidote to the disposition as being the gravitational attraction of another planet; that is, something different from others applying an independent force on the planet (Bird, 2005, 360).

This case is obviously clear. We can see that it is not easy to find helpful evidence to consider planets being disposed to travel in ellipses. Moreover, it can be thought that to travel in ellipses is an instantiation of more fundamental and general laws. However, it cannot be deduced that there are no disposition, moreover the presence of dispositions is connected with the corresponding laws. The point of the case is to show that we are trying to describe a

disposition here; there are some factors that are deported by *ceteris paribus* clause in the suitable cp-law; and the antidote to the disposition will correlate with these factors.

Let's consider it in more detail. Arsenic is one of the potentially deadliest poisons in the world. The disposition of arsenic could be the ability to make humans seriously ill or even kill them. Such dispositions have antidotes, both naturally and philosophically. When a quantity of arsenic is ingested by someone, there will be no manifestation so long as an antidote has been taken, or if the person has undergone. An antidote can protect life when in a dangerous situation. There is another protection from this danger i.e. by a process of habituation. This is further from the natural sense of 'antidote', but much closer to the philosophical sense. In the presence of such antidotes, there is a disposition that makes people ill when ingested, although some of them may not be adversely affected by illness. According to Bird, "Hence it is no surprise that the corresponding law, that arsenic causes illness in humans, is not a truly universal law but is an exclusive cp-law" (Bird, 2005, p. 361).

The disposition has suffered from antidotes: these antidotes are the factors (as I have said before) excluded by the *ceteris paribus* clauses, such as taking antidotes, strengthening the immune system, and so on. In this specific example, the antidotes to arsenic makes the person in question change physiologically. However, there are some antidotes that do not work like these; such antidotes makes the poison change in chemical or biological ways. They render the poison harmless. In this case, it can be seen that the previous antidote is an 'antidote' in the philosophical sense, while this is an antidote in a natural sense. This disposition (that poisons cause illness) can be described as a finkish disposition, since the stimulus makes the disposition disappear; that is to say, when ingested the poison loses its disposition. Bird claims that "This possibility too is a reason why (CA) does not hold for this disposition, and is correspondingly a factor that is excluded by the *ceteris paribus* clauses in the associated laws. (Bird, 2005, p. 361)"

In a dispositional essentialist view of laws, (CA) fails due to finks and antidotes, but by exclusive cp-laws this account can still live. However, thanks to the existence of finks and antidotes, we can see that not all laws are general, but there are some exclusive cp-laws in the dispositional essentialist view of laws. Thinking speculatively, the dispositional essentialist view of laws would have necessitated that all laws are perfectly general, if (CA) had been live.

In this sense, cp-laws would have caused the dispositional conception to fail. However, we have seen that the existence of cp-laws confirms the dispositional conception, rather than refuting it, because we learnt from cp-laws that the dispositions might be exposed to finks and antidotes.

Conclusion

The discussion of Bird's dispositional essentialist view and cp laws has been divided into three main parts: Finkish Disposition, Antidotes and finally Ceteris Paribus Laws. It can be seen that due to some exceptions (finks and antidotes), the simple conditional analysis of disposition is false. In the dispositional account, Bird has shown that $(CA \rightarrow)$ fails because of some exceptional cases, such as finks and antidotes. Some philosophers believe that dispositional essentialism loses its value because of the falsity of $(CA \rightarrow)$, but Bird claims that this is not a negative failure of the view; rather it leads us to more sophisticated dispositional laws that consists of not only general laws, but also exclusive cp-laws.

In dispositional essentialism, in order to have a finkish disposition, the causal basis of the disposition should be made to disappear. The formulation as follows: there is an object X possesses the finkish disposition D, manifestation M and stimulus S. If the stimulus makes X lose D before M occurs, then disposition D would fail and consequently manifestation M does not occur. This finkish disposition leads us to think carefully that not all laws are perfect generalisations. There can be some different kinds of laws in a dispositional account. This is the advantage of this account.

The second concern is antidotes, which can be described as interfering changes to environmental conditions. Antidotes' effects on (CA) are fundamentally different from those of finks. When an antidote is taken, the disposition is still alive but there are some chemical or biological changes in the surrounding environment. As a result of this, manifestations fails to occur. This is also (like finks) an advantage of this account, since it serves to open the account to exclusive cp-laws. Thanks to finks and antidotes, we can see that dispositional essentialism can has not only universal laws, but also exclusive cp-laws, and that with these laws dispositional essentialism tells us much more.

Exclusive cp-laws can be seen as reflections of dispositions, and finks and antidotes are the factors that permit counterexamples to conditional analysis. At the end, the dispositional conception of laws survives, thanks to the exclusive cp-laws, in spite of the counterexamples to (CA). There have been universal laws in dispositional conception of laws so far. But right now, the account consists of exclusive cp-laws as well. These laws help us the dispositional account of laws to be clearer and nuanced.

In conclusion, due to finks and antidotes, (CA) has to be false in a dispositional essentialist view of laws; on this point, exclusive cp-laws save the (CA) and the dispositional conception of laws. However, not only does the dispositional conception of laws work with universal general laws, but also, thanks to the existence of finks and antidotes, some exclusive cp-laws can find a place in the account. Consequently, it can be seen that the existence of cp-laws allows us to learn a positive view of the dispositional conception of laws that are subjected to finks and antidotes.

Conclusion

In conclusion, the discussion of the ceteris paribus laws in laws of nature in my thesis has been divided into four main sections: different view of laws of nature; David Lewis's best system analysis and cp laws; Armstrong's nomic necessitation view and cp laws; and finally Bird's dispositional essentialist view and cp laws. In this thesis, my main aim is to explore cp laws in three different views of laws of nature.

In the first section, I examined the different kinds of laws of nature, such as regularity theory, nomic necessitation theory and dispositional essentialism. This part can be seen as a broad introduction to my main aim: that is, to examine cp laws in these views.

As we have seen that regularity theory does not have any physical necessity, it can be said that regularities are a totality of true generalisations. There is no ontological status for regularity theory; the law of regularity theory is totally of instance, nothing more. We can say as an advantage of this view that laws support counterfactuals, but not accidental generalisation. Lewis's best system analysis is an alternative view for simple and counterfactual theories of regularities. In this account, laws cannot be established by accidental generalisation, since the fundamental duty for laws in the system is to systematize facts. This system arises from genuine laws and these are different from accidental generalizations, because the simplest and strongest systematization of facts makes regularities become genuine laws. We can say as a disadvantage of Lewis's BSA that laws are just regularities and nothing else. There is no further explanation for laws. It can be seen that regularities are laws in Lewis's BSA. Consequently, ridiculous truths can occur in BSA because of simplicity and strength, and when we establish a system it causes us to have a new best system. This is another disadvantage, called the trivialization problem, in Lewis's BSA.

The nomic necessitation theory goes against the regularity theory of laws of nature. In necessitation theory, both the instance of law and law itself are established by the connection of necessitation. The necessitation theory, therefore, brings forward the idea that laws are something more than a collection of regularities.

In this account, thanks to the introduction of universals, the difference between genuine laws and accidental generalizations has been foregrounded. According to nomic necessitation theorists, this law cannot be a sole expression of the regular progression of two instances (or two event-types). Rather, for the nomic necessitation theorists, the law says something more than a law, in the sense that it describes a relation between two universals or properties: the property is always co-instantiated with the property, because the necessary relation between two properties guarantees the co-instantiation.

A disadvantage of the nomic necessitation view is the existence of universals. Armstrong's position for the universals is not the same as that of the Platonists, in the sense that Armstrong do not want to claim that the existence of universals is outside space-time (there is no existence of redness independently when red particulars are not present). However, there are still some problems for the nature of necessitation as a universal according to some philosophers. A regularity theorist, for instance, could essentially argue that nomic necessitation theorists will really be saying nothing at all due to the fact that there is no difference between the argument of 'Fness necessitates Gness' and 'there is a law that Fs are Gs'.

The third view (and the most important view for me) is dispositional essentialism. This view differs from the two previous understanding of the laws of nature in two fundamental ways. First, laws are thought to be *contingent* on the two previous accounts, whereas *metaphysical necessity* has been introduced by the dispositional account. Second, while properties are thought to be *categorical* in the two previous accounts of laws, in the dispositional account, they have essential nomic or causal powers.

In dispositional essentialism, the essence of properties is established by nomic and causal powers essentially. The causal power is related to its causes and effects potentially and the nomic power is related to the real meaning of the theory. Properties are implied by dispositionalism such that P and Q could be identical to each other when they have the same powers (causal and nomic). So, properties empower their instances with the same disposition.

In conclusion, we examined Lewis's theory of lawhood in the second section on BSA and whether laws with exceptions are allowed. Firstly, I would like to express that Lewis does not accept fundamental laws with exceptions in his BSA account. However, Callender and Cohen claim that

BBS does not require that aspirants to the title of lawhood should be universal and exceptionless. An incomplete generalization may be sufficiently simpler than any complete one, and thereby gain entry into the Best System. (Callender & Cohen, 2010 p. 441)

In this regard, It can be said that Callender and Cohen (2010) and Schrenk (2007, 2008) are happy with cp-laws in BSA. Schrenk (2007, 2008) puts forward a reconstruction of cp-laws in BSA. For Schrenk, (Lewis agrees), facts have fundamental features in the BSA. I agree with Lewis and understand that cp-laws are not crucial for Lewis's analysis of BSA; however others such as Unterhuber, Callender and Cohen believe that cp-laws perform better than other laws (strict laws).

As we saw that in this section, I evaluated the general knowledge of nomic necessitation, identification and inference problems and oaken/defeasible laws (laws with exceptions) respectively in Armstrong's view of nomic necessitation. The concept of oaken or defeasible laws (Armstrong offers these as laws with exceptions) can be seen as metaphysically controversial.

There is no sharp distinction between iron laws and oaken laws for Armstrong. Therefore, sometimes these terms for laws are used interchangeably. Because of this, I am forced to explain oaken laws as a law with exception in the nomic necessitation view.

As we have seen in the dispositional part, the simple conditional analysis of a disposition is obliged to be false, because finks and antidotes cause some of its components to be destroyed. In the dispositional account, Bird has shown that $(CA \rightarrow)$ fails because of some exceptional laws, such as finks and antidotes. Some philosophers believe that dispositional essentialism loses its value because of $(CA \rightarrow)$, but Bird claims that this is not a failure of the view; rather it leads us to more sophisticated dispositional laws that consist of not only general laws, but also exclusive cp-laws.

In dispositional essentialism, in order to have a finkish disposition, the causal basis of the disposition should be eliminated. This finkish disposition leads us to think carefully that not all laws are generalisations. There can be some different kinds of laws in a dispositional account. This is the advantage of this account.

Finally, considering all the preceding chapters, in my opinion, dispositional essentialism is the most important view and my stance is from that view, because my main interest (as I said earlier) is to learn in which view cp-laws are allowed. Right now, we know that cp-laws can take the best position in dispositional essentialism. Moreover, this makes the view more sophisticated, meaning that the dispositional essentialist view, after cp-laws are allowed, gives us more. So we have seen that, when we compare with these three views, cp-laws in the dispositional essentialist view are more useful than both Lewis's BSA and Armstrong's view of nomic necessitation. Some philosophers of science argue that dispositional essentialism fails because (CA) suffers from finks and antidotes. On this point, Bird claims that this is actually not a disadvantage of the view. Rather, it helps us to improve the view and so the view say more to us than previous versions. Thanks to finks and antidotes, dispositional essentialism can include both universal laws and exclusive cp-laws. Due to the all these facts, I agree with Bird and defend his view of dispositional essentialism.

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