SCIENTIFIC REALISM
VIS-À-VIS
THE EVOLUTIONARY DEBUNKING ARGUMENT

A Master's Thesis

by
DAMLA UYAR

Department of Philosophy
İhsan Doğramacı Bilkent University
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For

all *Women* and *Queers* out there;

who taught, and still teaches, me to endure

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DAMLA UYAR

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ABSTRACT

SCIENTIFIC REALISM VIS-À-VIS THE EVOLUTIONARY DEBUNKING ARGUMENT

Uyar, Damla
M.A., Department of Philosophy
Supervisor: Assoc. Prof. Dr. William Giles Wringe

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Evolutionary debunking arguments (EDA) are widely used in moral philosophy literature, and have been used as a skeptical challenge to moral realism. Whether such an evolutionary debunking argument can also apply to scientific realism, on the other hand, is not a hotly debated topic. Such a challenge is posed by Christophe de Ray, in his article "An Evolutionary Sceptical Challenge to Scientific Realism" (2022). De Ray argues that scientific realism engages in abductive reasoning, which relies on the metaphysical intuition that *facts generally have explanations for their obtaining*. In light of the evolutionary theory, however, he claims that the reliance on this metaphysical intuition is unjustified—putting scientific realism in the position of undermining itself in the face of a Darwinian Dilemma. To assess whether such an EDA can target different versions of scientific realism, I am examining these three realist positions: Epistemic Structural Realism (ESR), Ontic Structural Realism (OSR), and Entity Realism. Against de Ray, I argue that although the two versions of structural realism (ESR and OSR) are the targets of EDA against scientific realism, there is at least one version of scientific realism, Entity Realism, that does not become such a target.

Keywords: Evolutionary Debunking Argument, Epistemic Structural Realism, Ontic Structural Realism, Entity Realism

ÖZET

EVRİMSEL ÇÜRÜTME ARGÜMANI KARŞISINDA BİLİMSEL REALİZM

Uyar, Damla
Yüksek Lisans, Felsefe Bölümü
Tez Danışmanı: Doç. Dr. William Giles Wringe

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Evrimsel çürütme argümanları (EÇA), ahlaki gerçekçiliğe şüpheci bir meydan okuma olarak ahlak felsefesi literatüründe yaygın olarak kullanılmaktadır. Öte yandan, böyle bir evrimsel çürütme argümanının bilimsel realizme de uygulanıp uygulanamayacağı aynı ölçüde tartışılan bir konu değildir. Böyle bir meydan okuma, Christophe de Ray tarafından "Bilimsel Realizme Evrimsel Şüpheci Bir Meydan Okuma" (2022) makalesinde sunulmaktadır. De Ray, bilimsel realizmin; *olguların ortaya çıkmalarının genellikle bir açıklaması olduğu* şeklindeki metafizik sezgiye dayanan hepten gidimsel çıkarımla iştigal ettiğini öne sürer. Fakat, evrim teorisi ışığında, bu metafizik sezgiye güvenmenin gerekçelendirilmemiş olduğunu iddia ederek, bilimsel realizmin, bir Darwinci İkilem karşısında kendi altını oyduğunu iddia eder. Böyle bir EÇA'nın bilimsel realizmin farklı versiyonlarını hedefleyip hedefleyemeyeceğini değerlendirmek için şu üç realist pozisyonu inceliyorum: Epistemik Yapısal Realizm (EYR), Ontik Yapısal Realizm (OYR) ve Varlık Realizmi. De Ray'e karşı, yapısal realizmin iki versiyonunun (EYR ve OYR) bilimsel realizme karşı EÇA'nın hedefi olduğunu, ancak Varlık Realizminin böyle bir hedef haline gelmeyen en az bir bilimsel realizm versiyonunu oluşturduğunu savunuyorum.

Anahtar Kelimeler: Evrimsel Çürütme Argümanı, Epistemik Yapısal Realizm, Ontik Yapısal Realizm, Varlık Realizmi

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INTRODUCTION

Evolutionary debunking arguments (EDA) are often used in metaethical discussions against moral realists. Although scientific realism has been subject to various kinds of objections and criticisms, the evolutionary debunking of realism has not been discussed to any significant extent. In fact, such a discussion could have more serious consequences for scientific realism. Because, for scientific realism, the idea that evolutionary theory, as one of our best scientific theories, poses such a threat is doubly threatening.

One such challenge is posed by Christophe de Ray in his article "An Evolutionary Sceptical Challenge to Scientific Realism" (2022). Here de Ray argues that the implication of evolutionary theory for our innate metaphysical intuitions confronts scientific realism with a Darwinian Dilemma. As a result, scientific realists must either choose the first horn and withhold their realist belief, or, to remain a realist, they must choose the second horn and deny evolutionary theory. Both options are untenable for the scientific realist.

However, de Ray himself chooses the easy way out by presenting a global argument against scientific realism. This is the easy way, because scientific realism is a broader position within the philosophy of science, encompassing a variety of arguments and positions in its favor. To conclude that scientific realism *tout court* fails in the face of this EDA, it must be shown that no version of it survives. Therefore, in this thesis, I attempt to assess whether this is the case. To this end, I focus on three variants of scientific realism: Epistemic Structural Realism, Ontic Structural Realism, and Entity Realism.

The importance of this discussion over scientific realism is that it poses a distinctive objection to scientific realism. Because arguments showing that a position is self-

undermining, by pointing to the fact that the consequences of the very premises of the position undermine the position itself, is more problematic compared to arguments merely targeting the premises. In the present context, we have a position, viz. scientific realism, that is argued to be self-undermining by an argument, viz. the EDA against it. I believe, this is a different objection to scientific realism than other historical examples. Thus, it is important to show that there can be a way out for scientific realism in such a threatening case.

In the first chapter, I dissect de Ray's EDA against scientific realism. First, I lay out the relationship between scientific realism, inference to the best explanation, and the metaphysical belief that facts generally have explanations for their obtaining. Then, I show the connection between the metaphysical belief and the metaphysical intuition. Finally, I present the main evolutionary skeptical challenge to this metaphysical intuition, which implies a Darwinian Dilemma for scientific realists. I then compare the similarities and dissimilarities of the EDA against scientific realism with the EDA against moral realism to evaluate the distinctive features of the former.

In the second chapter, I examine whether structural realism, in both its epistemic and ontic versions, becomes the target of the EDA. Structural realism, insofar as it relies on the No-Miracles argument and IBE, falls victim to the Darwinian Dilemma. Therefore, this chapter concludes that, against EDA, scientific realism cannot be defended in its structural realist version.

In the third and final chapter of the thesis, I pose the question of whether entity realism is also a target of the EDA. After presenting the main arguments for entity realism, I propose two interpretations of this position, each leading to different conclusions regarding this project. In its Legitimate-Inference interpretation, entity realism also becomes a victim of the EDA as it relies on inference. However, I argue, in its Tool-Based interpretation, entity realism avoids the problem of inference altogether. This leads me to conclude that there is at least one version of scientific realism that is not a target of the EDA against scientific realism.

CHAPTER 1

THE EVOLUTIONARY DEBUNKING ARGUMENT AGAINST SCIENTIFIC REALISM

This chapter presents an Evolutionary Debunking Argument (EDA) against scientific realism. The EDA that will constitute the concern of this thesis is put forward by Christophe de Ray (2022), in his article "An Evolutionary Sceptical Challenge to Scientific Realism". Although discussions around EDAs are prevalent in metaethical discourse on realism, we do not encounter a similar dynamic when it comes to realism regarding science. Thus, first, I will introduce de Ray's EDA against scientific realism. I will then lay out the structure of EDAs as they are used in metaethics, to understand how an EDA works, and evaluate the similarities and differences of the EDA against scientific realism from EDAs in metaethics. I see this comparison as crucial because although they use similar argumentative structures, the logic of the EDA against scientific realism is slightly but crucially different from EDAs in metaethics: while the EDA against moral realism at most can target to show that the position is not compatible with current science, the EDA against scientific realism aims to show that the position itself is self-undermining insofar as it is incompatible with science. However, since the focus of the thesis is on an analysis of the strength of scientific realism in the face of de Ray's EDA, I will conclude the chapter by highlighting the weight of de Ray's argument for scientific realists.

1.1. The EDA against Scientific Realism

The key point of Christophe de Ray's argument is that, given evolutionary theory, the idea that we have sound metaphysical intuitions becomes what Sharon Street

calls a “remarkable coincidence” (Street, 2006: 132). This presents scientific realists with a Darwinian Dilemma because of their reliance on the metaphysical intuition, which in turn entails that scientific realism undermines itself. As I will demonstrate, de Ray’s argument rests on three sub-arguments, which I will break down in three subsections. The first concerns the relationship between scientific realism, Inference to the Best Explanation (IBE), and the metaphysical belief. The second part attempts to establish the relationship between the metaphysical belief and the metaphysical intuition as a belief-forming method. And the third part presents the main evolutionary debunking argument.

1.1.1. Scientific Realism, IBE, and the Metaphysical Belief

Before setting out the argument against scientific realism, it is crucial to see how de Ray construes this position. According to de Ray, scientific realism is “the view that our best scientific theories accurately represent real, mind-independent states of affairs” (de Ray, 2022: 971). To anyone familiar with the variety of positions in scientific realism, this may seem like a restricted view of scientific realism as *theory-realism*. For now, however, let us remain faithful to de Ray’s definition of the term in order to understand his argument.

The relationship between scientific realism and IBE is based on the relationship between sciences and IBE. The sciences use IBE as their primary method of inference (de Ray, 2022: 971). This means that scientific theories are the products of IBE. Since scientific realism is a realist commitment to scientific theories, it follows in de Ray’s interpretation that scientific realism is also committed to IBE.

This commitment to IBE in itself does not make scientific realism problematic. What does make it problematic, however, is the metaphysical belief *immanent* in IBE. De Ray follows Peter Lipton’s characterization of IBE. According to Lipton, IBE is a two-stage process in which, first, potential candidate explanations consistent with the evidence are generated, and then the best among them is inferred to be the actual explanation based on its explanatory virtues (Lipton, 2003: 56-64). Inference thus proceeds from the *best* explanation to the actual *true* explanation. This inference from the explanatory virtue of a theory to its truth makes IBE illegitimate and thus

scientific realism problematic for de Ray, because he argues that this step is based on a background metaphysical belief that will be shown, in the main argument, to be unjustified.

De Ray argues that IBE presupposes that every explanandum has an explanans, i.e., that the world has a particular character of being *explainable*. He believes that this presupposition amounts to the belief that *facts generally have explanations for their obtaining* (de Ray, 2022: 972). Moreover, this is a *metaphysical belief* since it is a belief about the world as a whole, that the world has a profound explanatory structure.

The relationship between scientific realism, IBE, and the metaphysical belief is now obvious. Scientific realism is a realist commitment to scientific theories; scientific theories are products of IBE, and IBE relies on the metaphysical belief that facts generally have explanations for their obtaining. The first conclusion in de Ray's tripartite argument, then, is that *scientific realists must also be committed to this metaphysical belief*. Next, it should be shown how this metaphysical belief is related to metaphysical intuition.

1.1.2. The Metaphysical Belief and The Metaphysical Intuition

The second step of the argument depends on the claim that the metaphysical belief that facts generally have explanations for their obtaining is engendered by metaphysical intuition. This step of the argument can be seen as weakly formulated in some ways. For, de Ray justifies his claim that the metaphysical belief derives from intuition merely with the conviction that: "When faced with a novel fact, we intuitively feel that there must be some reason for its obtaining" (de Ray, 2022: 972). It is strange, to the point of incoherent, that while reliance on intuition constitutes the bulk of de Ray's skeptical argument, he doesn't give any extensive and convincing justification for his claim that the metaphysical belief derives from intuition—which itself, given the lack of such a justification, seems like relying on intuition. One may argue that such a metaphysical belief need not rely on intuition, that it can be justified in other ways. I will leave this possibility out for the sake of this discussion,

as it is beyond the limits of this thesis. For now, let's grant that this metaphysical belief relies solely on intuition, as de Ray argues.

Here, the concept of *intuition* is crucial as it will be recursively used in the argument against realists. But what is an *intuition*? De Ray's definition is as follows:

> I will take an intuition to be a kind of disposition to hold certain beliefs (following van Inwagen 1997). Thus, I will take it that an intuition is sound if the beliefs it produces are true. Moreover, I will take intuitions to be metaphysical if the content of the beliefs they produce is metaphysical (de Ray, 2022: 972).

After this brief definition, he does not explicitly discuss intuition again, although the argument relies heavily on this concept. However, from the overall structure of his work, it can be inferred that for de Ray, intuitions: i) are a kind of *belief-forming method*; ii) gain their characteristics according to the *content* of the beliefs they produce; iii) are *innate*, as opposed to artificial belief-forming methods.

The significance of intuitions for the argument seems to be that they are innate, and we rely on them to hold certain beliefs. The question is whether or not our instinctive reliance on them is justified, so that we can justifiably build rational arguments (e.g., scientific realism) by relying on the beliefs (e.g., the metaphysical beliefs) generated by these intuitions. The crucial question of the argument, then, will be whether there can be an explanatory connection between the reliability of intuitions as belief-forming methods and our instinctive reliance on them. Nevertheless, the conclusion that should be drawn from this second part of the argument is that *the metaphysical belief is a product of innate metaphysical intuition*.

1.1.3. The Main Evolutionary Skeptical Argument

With the conclusions about the relationship between scientific realism, IBE, and the metaphysical belief on the one hand, and between the metaphysical belief and the metaphysical intuition on the other, the main evolutionary skeptical argument can be stated. This is how de Ray formulates his argument (de Ray, 2022: 973):

1. If, given evolutionary theory, the soundness of our innate metaphysical intuitions would not at all explain our reliance on said intuitions, then believing evolutionary theory ought to make us distrust our innate metaphysical intuitions.

2. Given evolutionary theory, the soundness of our innate metaphysical intuitions would not at all explain our reliance on said intuitions.

3. Therefore, believing evolutionary theory ought to make us distrust our innate metaphysical intuitions.

The first premise requires a discussion over the justifiable use of belief-forming methods, while the second premise requires a debate about the plausibility of an evolutionary scenario on the explanatory link between the possession of a belief-forming method and the independent soundness of the beliefs it produces.

Let us start with the first premise. The premise problematizes the justification of reliance on a belief-forming method. One way to view such reliance as unjustified is that the belief-forming method leads to false beliefs most of the time. However, there is another way in which continued reliance on a belief-forming method can be unjustified, as de Ray argues. If reliance on a belief-forming method cannot be explained by the reliability of that method, then continued reliance on that very belief-forming method is unjustified (de Ray, 2022: 973). That is, if there is a lack of *explanatory connection* between the reliability of a belief-forming method and reliance on that method, then "reliance on a reliable belief-forming method would have taken a 'lucky accident'" (de Ray, 2022: 974), or what Street (2006) calls a "remarkable coincidence". Consequently, the first premise asserts that if there is no explanatory connection between the reliability of the metaphysical intuition and our reliance on it, then our reliance on the metaphysical intuition is unjustified.

Thus, to conclude that believing in the evolutionary theory should make us refrain from relying on the metaphysical intuition, it must be shown that the second premise is true. In justifying the second premise, de Ray adheres to evolutionary theory. Our

biological belief-forming mechanisms are given to us in the evolutionary process. Moreover, from the evolutionary perspective, which de Ray also endorses, if a trait is given and preserved by evolution in the long run, it must be the case that it is fitness-conducive for our ancestors in terms of survival and reproduction.

For example, in a footnote, Street argues that realism about non-evaluative facts such as the facts about objects in our environment is not a target of the evolutionary skeptical argument (Street, 2006: 160). For, the truth-tracking account provides us with the best explanation in these cases for why we have such a capacity to produce non-evaluative beliefs. According to Street, the best evolutionary explanation for the capacity to have such non-evaluative beliefs, is that there are *indeed* such facts out there in the world, knowledge of which thus increases reproductive success.

However, de Ray argues this is an abrupt conclusion: "Not all kinds of true beliefs would have benefited our ancestors, in evolutionary terms" (de Ray, 2022: 975). The metaphysical intuition about the explanatory structure of the world is a cognitive mechanism we acquired in the evolutionary process. Nevertheless, the vital question is whether it was given to us by evolution because this mechanism produced *true* metaphysical beliefs. To affirm this, we must be able to show that this mechanism was given and has been maintained in the evolutionary process because being disposed to believe in such metaphysical truths would have given our ancestors a significant evolutionary advantage, since the world does indeed objectively have such a metaphysical character. In other words, we must be able to show that the truth-tracking account is the best alternative to explain our innate metaphysical intuition.

De Ray thinks that this is untenable from an evolutionary perspective. This is because he argues that high fitness-conducive behavior is compatible not only with being intuitive metaphysical realists but also with being intuitive Humean *empiricists* (de Ray, 2022: 976). Our ancestors could have been this sort of intuitive empiricists, believing that observable events are merely stable regularities without any deep metaphysical properties underlying them. This would not have harmed their survival and reproductive success.

> Had our prehistoric ancestors been intuitive empiricists, they could still have behaved in fitness-conducive ways. Indeed, whether they represented tigers as groundless 'bundles of sensations' or mind-independent material beings underlying said sensations would not have mattered, as long as they stayed away from them. Getting mauled by a tiger is painful, even if the process is nothing over and above a series of unpleasant sensations. And even if they believed that tigers cease to exist when unexperienced, they could still have been wary of them while not experiencing them, as long as they also believed that sensations (and bundles of sensations, like tigers) are governed by sufficiently stable regularities (de Ray, 2022: 976).

This means that the independent soundness of the metaphysical intuition, i.e., whether the world in itself has such a deep explanatory structure, is irrelevant to the occurrence of the adaptive behavior in question (e.g., staying away from the tigers). Even if the world mind-independently exists as such, the empiricist intuition as well as the metaphysical intuition yields to the same kind of adaptive behavior that is necessary for reproductive success—suggesting that the metaphysical intuition is not given by the evolutionary process because it was truth-tracking.

Moreover, since the metaphysical intuition, by virtue of being such, concerns not only our observable environments but also the world as a whole, it is doubtful that it would be evolutionarily advantageous to have such a sound intuition about the unobservable micro and macro features of the world (de Ray, 2022: 977).

This leads to the conclusion that there is no explanatory connection between the soundness of metaphysical intuitions and our reliance on those intuitions. This shows that the second premise of the argument is true.

Notice that the main argument takes the form of a *modus ponens*. If one believes in the truth of the premises, the skeptical conclusion follows: *Believing evolutionary theory should make us refrain from relying on the innate metaphysical intuition that facts generally have explanations for their obtaining*. The final step is to show how this conclusion targets scientific realism.

1.1.4. Scientific Realism Undermines Itself

The evolutionary skeptical conclusion of the main argument does not directly refute scientific realism. It does, however, entail a Darwinian Dilemma for scientific realism. Recall that de Ray construed scientific realism as theory-realism, i.e., as the view that our best scientific theories represent mind-independent, real states of affairs. Given that, they must also accept evolutionary theory as one of our best scientific theories, as this is a prerequisite of their position. Moreover, it should be remembered that de Ray argued for the scientific realists' commitment to the metaphysical belief that facts generally have explanations for their obtaining. As discussed in the previous subsection, this metaphysical belief as a product of unreliable metaphysical intuition is unjustified.

Taking all these into account, de Ray poses the Darwinian Dilemma as follows (de Ray, 2022: 978). The first horn of the dilemma states that scientific realists must accept the evolutionary theory and thus withhold the unjustified metaphysical belief that facts generally have explanations for their obtaining. However, withholding this metaphysical belief *undermines* scientific realism since the position itself is a commitment to the view that our best scientific theories represent real states of affairs. On the other hand, the second horn of the dilemma asserts that scientific realists, in order to remain as such, must hold this metaphysical belief. However, the consequence of holding this metaphysical belief is that they must deny the evolutionary theory itself together with the conclusion of the evolutionary skeptical argument—which also *undermines* their position as scientific realists. The bold conclusion is that *scientific realism is self-undermining in the face of evolutionary theory*.

Before a comparison with the EDAs in meta-ethics, let me put a caveat regarding a discussion of what being a scientific realist amounts to. Recall that de Ray construed scientific realism as "the view that our best scientific theories accurately represent real, mind-independent states of affairs" (de Ray, 2022: 971). Earlier, I noted that this seems like a restricted view of scientific realism as theory-realism. But what does being a scientific realist *really* amount to?

It is generally accepted that scientific realism in the broad sense consists of three realist commitments: metaphysically, a commitment to the existence of a mind-independent world; semantically, a commitment to that scientific claims have truth-values; and epistemically, a commitment to the belief that scientific theories give the knowledge of the world, i.e., that they are approximately true and the entities they posit do partake in the world (Psillos, 1999; Chakravartty, 2017). This is the general recipe for a thorough realism.

However, mostly, at least in its contemporary forms, scientific realism doesn't commit to all aspects of science across the board. Rather, scientific realists generally embrace a selective version of realism "in terms of an epistemically positive attitude toward those aspects of theories that are most worthy of epistemic commitment" (Chakravartty, 2017). According to their epistemic commitments, they divide into three camps: explanationist realism, structural realism, and entity realism.

It can be articulated that all these three versions of restrictive realism in a sense commit to the three aspects of realism. All of them have a metaphysical commitment to an independently-existing world, a semantic commitment to those parts of science towards which they take a realist attitude, and an epistemic commitment restricted in a similar sense. In this sense, they all seem to fall under de Ray's definition of scientific realism in this or that way. However, as I will also discuss in the third and final chapter of the thesis, entity realism, although a version of scientific realism, doesn't share de Ray's definition as it takes an antirealist or at least agnostic stance regarding scientific theories and as is realistic in an experimental sense. Unlike, but similar to some extent, to de Ray, a modified definition of scientific realism as such may cover all these versions: *scientific realism is the view that scientific practice (either in its theory version or experimental version) accurately represents real, mind-independent states of affairs*. Putting this on one side, let me proceed to the comparison between the EDA against scientific realism and the EDA against moral realism.

1.2. EDA in Meta-Ethics: A Comparison

EDAs, as undermining defeater arguments, were originally born out of the discussions of metaethics. The idea of evolutionary skepticism in relation to morality is by no means new in the literature. However, as generally accepted, Sharon Street's (2006) notorious "A Darwinian Dilemma for Realist Theories of Value" is its flagship version and has become the conventional form of an EDA against moral realism. Thus, since this thesis is primarily concerned with an EDA against scientific realism, it is useful to understand how an EDA works logically in moral realism debates, and Street's argument is an excellent example of such a project. I would now like to present Street's argument and expose her terminology.

Street argues that given evolutionary theory, and accordingly the influence of evolutionary forces on our evaluative attitudes, moral realism faces a Darwinian Dilemma. The realist must either deny an explanatory relationship between the evolutionary pressures on our evaluative attitudes and those independent evaluative facts or truths, or must accept that there is such a relationship (Street, 2006: 109). The first horn of the dilemma leads to skepticism about the evaluative attitudes because it implies that they are off-track, given that it would be a *remarkable coincidence* for those evolutionarily-influenced attitudes to accord with independent truths. On the other hand, the second horn leads the realist to unscientific grounds because *the tracking account* put forward by these realists is outcompeted by *the adaptive link account*. The conclusion is that both options are untenable in the face of evolutionary theory (Street 2006: 135).

However, there is a possible objection to this anti-realist challenge. The objection is called *the byproduct thesis*. According to this thesis, while the capacity to grasp evaluative truths may not itself have been evolutionarily selected, it may arise as a byproduct of another capacity that has been selected as such (Street, 2006: 142). Indeed, long ago Henry Sidgwick (Sidgwick, 2011/1905) and more recently Katarzyna de Lazari-Radek and Peter Singer (Lazari-Radek & Singer, 2014) as well as Derek Parfit (Parfit, 2011) have argued for moral realism along these lines in the face of evolutionary debunking. Despite their different construals, the crux of their argument is as follows. It is not rational to argue that our exclusive capacity for grasping independent moral facts is directly an evolutionarily advantageous trait. From an evolutionary perspective, however, we have acquired the capacity for

rationality to grasp some truths out there in the world (at the most basic level, to track facts about our physical environment as a fitness-conducive advantage), of which our more complex rational capacities for grasping truths beyond the observable physical level—such as those about astrophysics or evaluative facts—are a byproduct.

I will not discuss these byproduct arguments for moral realism in detail here. For now, it is sufficient to understand the gist of the argument, because, as will be discussed in the next chapter, some scientific realists argue for realism by using a similar byproduct argument.

Street argues that this byproduct thesis for moral realism is also a target of the Darwinian Dilemma. This time, the realist must account for the relationship between this evolutionary capacity and the independent evaluative truths (Street, 2006: 142). Again, the realist can resort to the first horn claiming that there is no relation but then must admit that it is just a sheer chance that this general capacity allowed for a byproduct capacity to grasp evaluative truths. Or, the realist can opt for the second horn and claim that there is such a relation. However, Street concludes that there seems to be no convincing explanation as such. Thus, the byproduct thesis also fails in the face of a Darwinian Dilemma.

Notice that Street's EDA is not an undermining defeater for our evaluative beliefs, but rather for the meta-ethical, realist account for these beliefs. Guy Kahane underscores this crucial point about the actual function of debunking arguments: "A debunking argument does not show that an evaluative attitude is unjustified but it *can* show that the *belief* that this attitude is justified is unjustified" (Kahane, 2011: 110). In other words, a debunking argument is a defeater for the second-order meta-beliefs about the first-order beliefs. In fact, Street does not argue that evolutionary theory ought to make us distrust our evaluative beliefs, nor that it leads to a skeptical conclusion about such beliefs. On the contrary, she contends that if one opts for the first horn within the realist meta-ethical position by denying any explanatory relation, *this* precisely leads to a skeptical conclusion for our evaluative beliefs.

De Ray's Darwinian Dilemma against scientific realism is similar in nature to Street's. Moreover, as will be shown, the byproduct thesis is also adopted by some scientific realists to justify certain metaphysical beliefs underlying their realist position toward science. There are, however, significant differences between de Ray's and Street's versions of the Darwinian Dilemma, such as the targets of their skeptical conclusions.

As noted earlier, Street does not pose a skeptical challenge to our first-order evaluative beliefs. Rather, she seeks to establish an empiricist understanding of evaluative truth, to preserve the truth-value of evaluative beliefs. Her skeptical challenge targets moral realism, the second-order belief that our evaluative beliefs correspond to independent evaluative truths. Now, compare this with de Ray's case. De Ray directly challenges our first-order innate metaphysical beliefs or intuitions. Recall his skeptical conclusion: Believing evolutionary theory ought to make us distrust our innate metaphysical intuitions. And the reason for this conclusion is the lack of an explanatory connection between the independent metaphysical truths and our innate metaphysical intuitions, i.e., the unintelligibility of a truth-tracking account of our metaphysical intuitions on evolutionary grounds. This parallels Street's argument that on the evolutionary grounds, we cannot give a truth-tracking account of our moral beliefs. However, notice the radical difference in their claims upon the first-order beliefs they discuss. Street implies that we can still hold or trust our moral beliefs even though we should change our meta-ethical standpoint. De Ray, nonetheless, argues that we should distrust our metaphysical beliefs along with realism as our meta-level standpoint. Consequently, while Street's EDA debunks moral realism, de Ray's EDA in fact debunks the metaphysical intuition on which scientific realism is based. This leads us to question the credibility of de Ray's EDA as it departs from EDAs in general.

It can be argued that this apparent discrepancy between the two conclusions may be due to the peculiarity of the metaphysical intuition in question. For, whereas the moral beliefs featuring in the EDA discussions in metaethics do not cover or underpin the metaethical position itself, the metaphysical belief in question underlies the scientific realist position itself. In other words, as de Ray mentions, it seems that scientific realists should hold the metaphysical belief in order to remain scientific

realists whereas moral realists do not need to rely on the questioned moral beliefs as the basis of their metaethical position.

In view of all these, I believe we have an exclusive version of an EDA in the version put forward by de Ray against the scientific realists. Now, the fundamental question arises: Do all versions of scientific realism become a target of this EDA? In the next two chapters, I will strive to answer this question.

CHAPTER 2

STRUCTURAL REALISM VIS-À-VIS THE EDA

In the previous chapter, de Ray's EDA against scientific realism was presented. In order to assess whether scientific realism *tout court* is a target of this EDA, it must be shown that different versions of scientific realism do in fact fail to respond to the EDA. Scientific realism can be roughly divided into two camps, *Structural Realism* and *Entity Realism*. This chapter will examine whether structural realism is threatened by the EDA. Structural realists split into two positions according to their ontological positions on theoretical entities: *Epistemic Structural Realists* and *Ontic Structural Realists*. This chapter will first dissect Epistemic Structural Realism and then Ontic Structural Realism vis-à-vis the EDA. After the analysis, it will be concluded that Structural Realism in its two versions is a target of the EDA.

2.1. A Brief Introduction to Structural Realism

Structural realism is considered to be the most defensible form of scientific realism (Ladyman, 2020). It was explicitly formulated as a philosophical position firstly by John Worrall (1989), to argue for the problem of radical theory change along with the No-Miracles argument for realism. In its most general form, structural realism argues that we should be realists only with respect to the structural features of scientific theories, not with respect to science as a whole. In this respect, structural realism is a selective realist position. However, the metaphysical and epistemological implications of this principle is interpreted differently.

Some structural realists interpret this basic principle only epistemologically. According to them, we can be realists only with respect to the structural knowledge we have about the structure of the external world, but the nature of the things remains unknown to us. Those who defend realism in this sense are called *Epistemic Structural Realists* (ESR). ESR divides into two camps, depending on which path they arrive at ESR. Stathis Psillos (2001) identifies these two different paths as *the downward path* to ESR and *the upward path* to ESR. On the other hand, some interpret the basic structuralist principle both epistemologically and metaphysically, arguing that we cannot intelligibly speak of the "unknown nature of things". All that there is, or at least all that we can realistically commit to, is not objects but only structures. This second position is called *Ontic Structural Realism* (OSR).

Thus, to assess whether structural realism becomes a target of the EDA, we need to examine whether different positions with their different arguments for structural realism become such a target.

2.2. The Downward Path to Epistemic Structural Realism

The downward path to ESR, as Psillos points out (Psillos, 2001: S18), starts from realist premises to arrive at a structural realist attitude toward science. The main worry underlying and motivating this position is to formulate a realist response to the problem of radical theory change, or more specifically, to *the pessimistic meta-induction* argument epitomized by Larry Laudan (1981). The pessimistic meta-induction argument broadly states that, given the vast array of empirically successful theories in the past which then have turned out to be non-referential and false once replaced by newer ones, a realist belief in the truth or the referential success of current theories becomes untenable. Although not exclusively and merely a response to this problem, the downward path to ESR strives to remain realist vis-à-vis the pessimistic induction.

The fuel for the downward path to ESR comes from the No-Miracles argument, i.e., from a realist reading of the success of science. Henri Poincaré, considered one of the early proponents of the position, states this relationship between the success of science and realism: "Now, we daily see what science is doing for us. This could not

be unless it taught us something about reality […]" (Poincaré, 1905: xxiv). Stated as such, this reading of scientific success is in no way distinct from the typical scientific realist attitude, for example that of Hilary Putnam who coined the No-Miracles argument with his famous statement that "realism is the only philosophy that doesn't make the success of the science a *miracle*" (Putnam, 1975: 73).

John Worrall, also another prominent proponent of the downward path to ESR, however argues that the No-Miracles argument or the success of science *simpliciter* cannot guarantee scientific realism:

> Scientific realism can surely not be *inferred* in any interesting sense from science's success. The 'no miracles' argument cannot *establish* scientific realism; the claim is only that, other things being equal, a theory's predictive success supplies a *prima facie* plausibility argument in favour of its somehow or other having latched onto the truth (Worrall, 1989: 102).

However, the structuralist reading becomes distinctive when the phenomenon of radical theory change comes into play. It is crucial to notice that the pessimistic meta-induction generally targets realism on the grounds that there is a discontinuity in the ontology of theories in the case of theory-change. ESR, on the other hand, at least the downward path version advocated by Poincaré and Worrall, argues that the problem of theory-change can be accounted for realistically if the focus of realism is shifted from entities to the *relations* between entities. For, according to the downward path to ESR, the structures and relations in scientific theories correctly capture the real relations between entities, although the non-relational nature of entities remains unknown. Poincaré gives a structural realist answer to the pessimistic meta-induction, or "the bankruptcy of science" worry as he calls it (Poincaré, 1905: 160):

> The differential equations are always true, they may be integrated by the same methods, and the results of this integration still preserve their value. It cannot be said that this is reducing physical theories to simple practical recipes; these equations express relations, and if the equations remain true, it is because the relations preserve their reality. They teach us now, as they did then, that there

> is such and such a relation between this thing and that; only, the something which then called *motion*, we now call *electric current*. But these are merely names of the images we substituted for the real objects which Nature will hide forever from our eyes. The true relations between these real objects are the only reality we can attain, and the sole condition is that the same relations shall exist between these objects as between these images we are forced to put in their place (Poincaré, 1905: 161).

Here, the realist stance, in conjunction with the No-Miracles argument, boils down to the idea that the structural continuity between successive successful theories indicates that they latch onto the real structures of the world. Moreover, this structural continuity can be traced in terms of shared or modified mathematical equations of the theories.

Worrall also argues for realism by following Poincaré, in insisting that theory change is "essentially cumulative" at the empirical level and non-cumulative at the theoretical level (Worrall, 1989: 109). Furthermore, even if ontologies and metaphysical assumptions shift between theories, mature scientific theories with novel predictive success share the structural similarities in terms of their explanandum—as the case of the using similar mathematical equations for optical phenomena notwithstanding the shift from Fresnel's to Maxwell's theory of light shows. Unlike Poincaré, however, and perhaps more extensively, Worrall points out that the structural continuity, which can be traced only in the form of mathematical equations, need not necessarily be that of similarity but can be that of *limiting cases* (Worrall, 1989: 120).

Not everyone is content with the idea that Worrall passes as a realist with this argument. For example, Stathis Psillos (1999) argues that the argument merely pointing the structural continuity between theory-change, in the form of formal-mathematical equations, is totally compatible with an antirealist and pragmatic standpoint and that thus there is a need for an extra argument to establish realism on the basis of structural continuity. He contends that he is "not aware of such an argument in Worrall's (and Poincaré's) writings" (Psillos, 1999: 152). As Psillos points out, Laudan also anticipates such a realist reading of the structural continuity.

However, Laudan concludes that if the argument is merely along these lines, without any further specification regarding the ontologies of theories, it is in a sense a "closet positivism" (Laudan, 1981: 40).

Giving credence to the idea that structural continuity thesis *per se* is not determinant for realism, I nonetheless doubt that Worrall's argument can be restricted to this interpretation. For Worrall specifies that his argument (which follows Poincaré's) not merely supplies a response to the problem of radical theory change, but it supplies this answer by underwriting the No-Miracles argument. Despite his remarks about the inadequacy of the No-Miracles argument to establish realism *per se*, Worrall nevertheless holds that a modified version of realism—by downgrading the claim about the *truth* to an *approximate truth*—would not make the novel predictive success of mature scientific theories miraculous (Worrall, 1989: 105). Given these, from the standpoint of structural realism, it is possible to both underwrite the No-Miracles argument and account for theory-change in the history of science.

Consequently, the two characteristic claims of the downward path to ESR can be stated as follows: i) Scientific theories correctly capture at least a part of the real relations between the entities in the external world; and ii) The nature, or intrinsic properties, of entities are unknowable insofar as these correspond to the non-structural aspects of the external world.[1] Therefore, the viability of ESR depends on the nature/structure distinction as Frigg and Votsis point out (Frigg & Votsis, 2011: 257); which constitutes the main topic of dispute between the defenders of ESR and OSR, as discussed in the third section of this chapter.

All these considered, Poincaré's and Worrall's downward path to ESR can be seen as a version of theory-realism, as is evident from their commitment not to the entities but to the structural properties of scientific theories. Given this, and the fact that de Ray explicitly targets theory-realism, it can be anticipated that the downward path to ESR will be an easy target of the EDA.

[1] Although this latter claim is not strictly touched upon by Worrall, he nevertheless endorses the nature/structure distinction in his reading of the switch from Fresnel to Maxwell's theory of light. See Worrall (1989: 119-120).

Recall that de Ray targeted scientific realism on the grounds that it is committed to IBE and the metaphysical intuition that facts generally have explanations for their obtaining, for scientific theories themselves are products of IBE. Moreover, the No-Miracles argument itself is an IBE as it infers realism from the success of science. Both Poincaré's and Worrall's realist arguments directly feature the No-Miracles argument or its modified version in this or that way (Worrall's "modified realism"), since they take the success of theories in latching onto the structure of the world as the explanans of the observed preservation of structural features through theory-change.

On the other hand, arguing that the structural features of theories, expressed in mathematical equations, correctly correspond to the real relational properties of entities out there in the world is grounded on the metaphysical intuition that facts generally have explanations for their obtaining. For, this idea implies that the structural explanations we have in our theories are the true explanations for things happening in the external world.

Following de Ray, then, it can be argued that the downward path to ESR is committed to the metaphysical intuition that facts generally have explanations for their obtaining. Granted that de Ray's EDA targets the unjustified reliance on this metaphysical intuition on evolutionary grounds, and thus argues that scientific realism undermines itself vis-à-vis evolutionary theory; it would follow that the downward path to ESR also undermines itself insofar as it shares the same metaphysical intuition.

2.3. The Upward Path to Epistemic Structural Realism

Nonetheless, ESR also has an alternative path. Bertrand Russell is considered by many (Psillos, 2001; Frigg & Votsis, 2011; Gower, 2000) to be one of the pioneers of structural realism and specifically of ESR, although he does not explicitly adopt such titles. After Stathis Psillos's classification (Psillos: 2001), Russell's argument for ESR is considered the upward path to scientific realism. For, Russell advocates for scientific realism not on the basis of the history and the success of science, but on the grounds of the causal theory of perception.

The main thesis of Russell's argument is that we can have knowledge only about the structures of the external world, through the common structural features of our perceptions. Here, the argument depends upon two claims, each of which must be justified. The first concerns the objectivity of perceptions and what is meant by the structure of perceptions. The second arises from the connection between perception, the external world, and *the structural isomorphism* of these two.

Russell's foundational premise is that we are certain of our perceptions and experiences. According to the causal theory of perception, which Russell argues to be a scientific view that we should adopt; i) There are external objects as causes of our perceptions, and ii) Perception does not provide direct knowledge of these external causes. Russell concedes that there cannot be a logical proof of the first claim, that there are external objects as causes of our perceptions. He even admits that this metaphysical belief is most likely an instinctive one (Russell, 1959/1912: 24-25). Nevertheless, he believes that we have good reasons to hold this belief. The reason can be said to be coming from the intersubjective-objectivity of our experience. To use Russell's own example (Russell, 1959/1912: 20-21), when we are seeing a table from a certain perspective, and when others see the same table from different perspectives, we all agree on certain qualities of the table despite the divergences in the totality of our experiences. There are differences, but similarities as well in our experiences. This attests to the fact that there is an external cause for our common experience, which is in the end an inference we derive from experience—i.e., which can never be argued for with deductive certainty. Russell contends that "It is the absence of identity which makes us reject the naïve realism of common sense; it is the similarity which makes us accept the theory of a common origin for similar simultaneous perceptions" (Russell, 1992/1927: 207).

Moreover, the similarity in our experience of the same object is due to its structural or relational properties, viz. its second-order properties. This claim depends on a metaphysical assumption, named the *Helmholtz-Weyl Principle* by Psillos (Psillos, 2001: S14), which asserts that different percepts imply different stimuli. From this assumption, Russell concludes that what we can know about the external world is confined to its structural properties inasmuch as we can only talk about the structural

properties of our percepts (Russell, 1992/1927: 227-228). Hence, by virtue of the structural isomorphism between external objects and our percepts, we can have inferential knowledge of the structure of the world, but the intrinsic or first-order properties of the objects remain unknown to us.

The assumption of the structural isomorphism between the percepts and the external world is deeply crucial to Russell's argument because it presupposes a one-one relationship between the structure of our perceptions and the real structures. According to Russell, this assumption, together with induction, is the cement for the inference from perception to science (Russell, 1992/1927: 259), since arguing that scientific knowledge grasps the true structural properties of the external world requires that the structures or relations in our scientific knowledge correctly mirror the objective structures. However, Russell himself is aware of this flaw in his argument. For he accepts the fact that there is theory-change in the history science, and this is due to a possible many-one relationship between real structures and the structure of our percepts and theories.

> This consideration makes all physical inference more or less precarious. We can construct theories which fit the known facts, but we can never be sure that other theories would not fit them equally well. This is an essential limitation on scientific inference, which is generally recognized by men of science: no prudent man of science would maintain that such-and-such a theory is so firmly established that it will never call for modification. Newtonian gravitation came nearer to this certainty than other theory has ever done; yet Newtonian gravitation has had to be modified. The fundamental reason for this uncertainty, which remains even when we assume all the canons of scientific inference, is the fact that our relation S, which connects the physical object with the percept, is many-one and not one-one (Russell 1992/1927: 255-256).

This can be seen as a mild prototype of the pessimistic-meta induction argument, or the awareness of such a threat from a realist standpoint. However, it is obvious that Russell does not have a realist argument for the continuity in theory-change, as claimed by the downward path to ESR.

Assuming a one-one relationship between the two structures, to justify the inferences from percepts, naturally draws some objections. Psillos argues that, even if the Helmholtz-Weyl principle is taken simply as a supervenience principle in the sense that stimuli overdetermine the percept, the principle is not strong enough to establish the isomorphism between the structures (Psillos, 2001: S15). The reason is that, the one-one relation cannot be asserted without doubt, since it is equally logically conceivable that the same stimuli may induce different percepts. Hence, the inferential knowledge about the external world from the percepts becomes futile if only this principle is assumed.

Russell's version of scientific realism, although does not explicitly feature a discussion of unobservable/theoretical entities or an investigation over actual successive scientific theories, can be said to fall into the broad camp of theory-realism. The reason is that, Russell proposes a realist commitment to structural features of our knowledge, viz. the embodiment of the real relations between entities, and refuses to apply such a commitment to the nature of entities conceived as individuals outside such relations. Accordingly, insofar as it is a version of theory-realism, at the very outset, it would not be nonsensical to think that it is also a target of de Ray's EDA.

Let us recall again the basic premises of de Ray's EDA. De Ray argued that scientific realism, as theory-realism, goes hand in hand with IBE. IBE is illegitimate because it derives the truth of an explanation from its explanatory success, which in turn rests upon the presupposition of the metaphysical belief that facts generally have explanations for their obtaining. The crux of de Ray's evolutionary skepticism was that the realist metaphysical intuition would not confer any significant evolutionary advantage on our ancestors, making continued reliance on the metaphysical intuition unjustified. It was precisely in this sense that Poincare and Worrall's downward path to ESR became an easy target of the EDA since it explicitly hinged on the No-Miracles argument, a direct instantiation of IBE.

Given this, can Russell's structuralist theory-realism withstand the evolutionary skeptical challenge, or does it fall victim to the same considerations as the downward

path to ESR? There are good reasons not to regard Russell's ESR as equivalent to the downward path to ESR, in the sense that the latter is a direct target of the EDA against scientific realism. Russell's case is, in my view, different and more complicated than that.

First of all, Russell's upward path, as opposed to the downward path to ESR, is not limited to the success of science, accordingly, not limited to the No-Miracles argument. Certainly, Russell may tend to presuppose that science is successful because it captures the real relations out there in the world. But his argument from the causal theory of perception and the inferential knowledge by means of perception does not feature or demand the No-Miracles argument. Given this, Russell's realism cannot be defeated with the same strategy that defeated the downward path to realism—i.e., it cannot be defeated by pointing out the problematic No-Miracles argument underlying the realist commitment.

For a straightforward assessment, let's dissect Russell's basic assumption for structural realism. The basic metaphysical assumption of his argument was that there is a structural isomorphism, a one-one relationship between the structure of the external world and the structure of percepts. As long as there is no logical proof or empirical justification for this, the assumption remains an unjustified metaphysical belief. In fact, it is a product of IBE and of the metaphysical intuition that facts generally have explanations for their obtaining. For, a belief in the structural isomorphism implies that the perceptual facts have deep metaphysical explanations for their obtaining, nested in the relations between the independently existing things.

However, as Psillos's objection indicates, the Helmholtz-Weyl principle, to which Russell adheres, is not strong enough on its own to establish the isomorphism. The principle itself is also dubious, since it assumes that different stimuli induce different percepts. It appears that Russell's argument is flawed with intuitions and is circular: insofar as it attempts to establish realism on the basis of structural isomorphism, it leans on metaphysical realism to establish the structural isomorphism in its turn.

Russell himself even acknowledges that these assumptions have an intuitive origin, recognizing that the metaphysical belief in an independent external world is not

ultimately provable (Russell, 1959/1912: 22; Russell, 1992/1927: 199). About this metaphysical belief, Russell claims, "We find this belief ready in ourselves as soon as we begin to reflect: it is what may be called an *instinctive* belief" (Russell, 1959/1912: 24). Granting this, it seems that Russell's argument is wide open to de Ray's EDA.

However, regardless of their strength, Russell has reasons to hold onto instinctive beliefs. He believes that there is no compelling reason to *reject* instinctive beliefs unless they contradict other beliefs, and insofar as they provide simplicity and systematization for our experiences: "All knowledge, we find, must be built upon our instinctive beliefs, and if these are rejected, nothing is left" (Russell, 1959/1912: 25).

That being said, these reasons nevertheless do not provide any justification for retaining the belief in an independent external world, vis-à-vis de Ray's evolutionary skepticism. For, recall, de Ray makes it clear that unless intuitive realism is shown to be advantageous in evolutionary terms, there is no justification for holding it, since intuitive empiricism is perfectly compatible with fitness-conducive behavior.

On the other hand, Frigg and Votsis think that there might be a justification for the assumptions used in Russell's argument for realism, assuming both the Helmholtz-Weyl (HW) principle and the converse principle *WH* which states that different stimuli imply different percepts (Frigg & Votsis, 2011: 237). They think that navigating in a world without the use of these principles would be nearly impossible. Without the HW, the same stimulus would induce different percepts; for example, recognizing a tiger would be impossible as the same stimulus wouldn't induce the same percepts that would amount to the perception of a tiger. As for the WH, without it, different stimuli would induce the same perception; for example, different behavior of people wouldn't induce different perceptions in us. Thus, they argue, "having a neurophysiology that functions in accordance with both HW and WH confers significant evolutionary and learning advantages" (Frigg & Votsis, 2011: 237).

Can this empowered version of Russell's realism elude the EDA? Or can it be considered a realist critique of de Ray's evolutionary story? It can be argued that

there could be a different intuition at work in this Russellian argument, which is evolutionarily advantageous for our ancestors. If this is the case, as the HW and the WH principles show, then the metaphysical intuition at work can be that there are things out there corresponding to what we are perceiving. However, this intuition may not be problematic as the one de Ray argues against, because at least *prima facie*, it seems that this kind of intuition can be evolutionarily advantageous—i.e., that we can justifiably continue to rely on it and use it as the basis of our realist commitment.

Given this Frigg-Votsis argument along the Russellian lines, it seems a plausible thesis to investigate further. However, for the moment, although it seems promising, I believe we need more solid empirical backup from evolutionary biology and neurophysiology to argue as such. So, maybe there is a way out for the Russellian version of ESR to evade the EDA, but I will not pursue this possibility here as it requires an extensive study that exceeds the limits of this thesis.

2.4. Ontic Structural Realism

Another prominent position in structural realism is its Ontic Structural Realist (OSR) variant. Following Psillos's earlier classification (Psillos, 2001), OSR is also a version of the downward path to realism, as the position tries to establish scientific realism from the realist assumptions themselves, just like the downward path to ESR does. However, the two positions have different motivations for following the downward path, and reach different structuralist conclusions.

The downward path to ESR's motivation is primarily to combat the pessimistic meta-induction argument and to give a realist account for theory-change. For this reason, the position relies mainly on the history of science to justify realism. On the other hand, OSR's motivation is to follow the implications of our current best scientific theories to establish our metaphysical views, especially the implications of quantum physics. Accordingly, a *naturalistic* metaphysics is advocated and promoted. James Ladyman and Don Ross explicitly frame this point as "we think that contemporary science provides evidence for some positive metaphysical claims and theses" (Ladyman & Ross, 2007: 27), and again Ladyman as "if we are to be scientific

realists […] we should surely have our metaphysics informed by our best physics" (Ladyman, 2001: 70-71).

The motto of OSR, espoused primarily by James Ladyman, Don Ross, and Steven French, can be briefly paraphrased as "structures without objects". These proponents of OSR argue that, given what quantum theory says about the physical world, we can at most be realists about structural relations but not about objects as individuals.

The motivation behind this thesis is the eagerness of ontic structural realists to resolve the discrepancy between the metaphysical and the epistemological commitments of realism. Recall that, roughly speaking, ESR claimed that there are both objects and structural relations in the external world, but we can have knowledge only of the latter. OSR's central objection to this formulation is that the postulation of the existence of unknowable objects is unjustified. In other words, OSR holds that we cannot make metaphysical claims about something to which we have no epistemological access in principle. This is the standpoint of OSR with respect to ESR.

However, this is not the only motivation for ontic structural realists to argue against the realist commitment to objects. More important than that, OSR contends that quantum theory challenges our traditional approach to metaphysics by positing the *indistinguishability postulate,* which renders the traditional *principle of the identity of the indiscernibles* (PII) problematic. In the framework of classical physics, elementary particles, although sharing their intrinsic properties like mass or charge, were regarded as individuals and thus distinguished based on the differences in their extrinsic properties such as their spatiotemporal trajectory. However, since two particles in a quantum state are indistinguishable in terms of their extrinsic properties, the individuality of objects (at least of fundamental physical particles) is cast into doubt (Ladyman, 2001: 63-65). Moreover, French also points to the problem of the identification of objecthood in biology, e.g., in identifying genes, and argues that this attests to a metaphysics not of objects but of structures (French, 2014: 345).

The implication of this, ontic structuralists argue, is that we should have a "thin" notion of individual objects that are contextually individuated according to the place they occupy in particular structural relations (French & Ladyman, 2011: 30); on the proviso that, upon further analysis, these individuated objects also dissolve into structural relations. The upshot is that it is no longer objects that are ontologically primary, but structures themselves.

In light of this, OSR argues that structural realism should not be construed as interpreting the theories as if they were revealing the relations supervening on the inaccessible objects that are the metaphysically fundamental constituents of the world, but rather as revealing nothing more than the modal structure of the phenomena.

To establish its realist commitment, OSR, unlike the downward path to ESR, does not directly and explicitly engage with the No-Miracles argument nor with the continuity in theory-change. Rather, it can be argued that it takes realism at face value. Nonetheless, ontic structuralists have something to say about both of these concerns. As for the No-Miracles argument, Ladyman contends that:

> […] even the constructive empiricist cannot do without some metaphysics, in particular, without a commitment to objective modal relations. It is just such a commitment that I think structural realism needs in order to be a realist position that can satisfy the intuition behind the no-miracles argument. If science tells us about objective modal relations among the phenomena (both possible and actual), then occasional novel predictive success is not miraculous but to be expected (Ladyman, 2001: 73).

As for theory-change; to distinguish the structural realist position from constructive empiricism, French and Ladyman argue that the objective modality expressed in theories is not mere generalizations about phenomena in the empiricist sense but are the causal structure. Thus, in theory-change, it is not only the empirical content that is preserved, but also the structural features.

> The advocate of OSR is not claiming that the structure of our current theories will be preserved simpliciter, but rather that the well-confirmed relations between the phenomena will be preserved in at least approximate form and that the modal structure of the theories that underlies them, and plays the appropriate explanatory role, will also be preserved in approximate form (French & Ladyman, 2011: 31-32).

OSR, *prima facie*, can combat the evolutionary skeptical challenge, because it overrides innate intuitions. Recall that the naturalistic disposition of OSR maintains that our metaphysical claims should be reconsidered and reconstructed in the light of the implications of scientific theories. As a matter of fact, similar to de Ray, Ladyman and Ross argue that our instinctive intuitions are not reliable sources for doing science and metaphysics, considering that having proficient intuitions to infer the structures of objective reality other than our immediate environments would not confer any evolutionary advantage for our ancestors (Ladyman & Ross, 2007: 2).

However, Ladyman and Ross are optimistic about the possibility of a *bona fide* and justified metaphysics imbued with mathematical and scientific reasoning. As they put it:

> Fortunately, people learned to represent the world and reason mathematically—that is, in a manner that enables us to abstract away from our familiar environment, to a degree that has increased over time as mathematics has developed—and this has allowed us to achieve scientific knowledge. Since this knowledge can be incorporated into unified pictures, we also can have some justified metaphysics (Ladyman & Ross, 2007: 2).

This amounts to saying that abstract and formal reasoning in the form of mathematics enabled us to reason scientifically and accordingly to be capable of grasping the knowledge of objective reality. Hence, in the struggle against the intuitions, but also against the traditional metaphysics which adheres to the worldview of classical physics, the ontic structuralists defend a scientific metaphysics.

Notice the similarity here to the byproduct thesis of some moral realists that is mentioned in the previous chapter. Moral realists argued, against the evolutionary debunking of realism, that it is evolutionarily possible to argue that our sophisticated capacity to grasp evaluative truths is a byproduct of our more basic capacity to grasp the truths contributing to our survival. The ontic structuralist argument for justified metaphysics is similar: Although our initial metaphysical intuitions are unreliable, we acquired the capacity for abstract reasoning through mathematical practice and this enabled us to grasp scientific and metaphysical truths. In other words, our capacity for grasping scientific and metaphysical truths is a byproduct of our capacity for abstract reasoning in the form of logic or mathematics.

However, Street argued that the byproduct thesis of realists itself is not exempt from the same Darwinian Dilemma. Recall, she argued that the realist now must account for the explanatory link between the cognitive capacity and the independent moral truths. Similarly, it can be argued that the ontic structuralist faces the Darwinian Dilemma as well. How can we show that i) our capacity for abstract reasoning and mathematics is truth-tracking in the first place, and ii) our capacity for grasping scientific and metaphysical truths relates to the truth-tracking abstract reasoning? The ontic structural realist must either deny that there are such relations and accept that our capacity for a scientific metaphysics is just sheer chance, or must accept that there are such relations but further needs to show the relations.

Also, this scientific backup for metaphysical beliefs and for scientific realism is not exempt from the evolutionary skeptical challenge de Ray himself poses. Indeed, de Ray also considers this argument of Ladyman and Ross, in developing his EDA (de Ray, 2022: 982-984). According to de Ray, the argument for scientific metaphysics, against the intuitive one, also derives from the same problematic metaphysical intuition that facts generally have explanations for their obtaining. For realists to argue for science as a reliable belief-forming method to acquire justified metaphysical beliefs, they must implicitly rely on the very metaphysical intuition in order to hold that science is the means of knowing the deep structures in the external world. Moreover, if the realist argues that science is reliable because it is successful, she is again on the wrong track of the No-Miracles argument—shown to be vulnerable to the evolutionary skeptical challenge.

In any case, there seems to be no way for the ontic structural realist to remain realist without having the metaphysical intuition that facts generally have explanations for their obtaining. Given this, the rest of the evolutionary skeptical argument applies equally well to OSR. Thus, OSR becomes a target of the EDA just as does the downward and the upward path to ESR.

2.5. Conclusion: Structural Realism is a Target of the EDA

All in all, despite their different argument routes to structural realism, both OSR and ESR (in their own ways) share the metaphysical intuition that facts generally have explanations for their obtaining. Moreover, as discussed, insofar as scientific realism depends on this unjustified metaphysical intuition, provided that this metaphysical intuition is not justified in another way, it faces the Darwinian Dilemma. Either the structural realist must accept the evolutionary theory and withhold the metaphysical belief, or she must hold the metaphysical belief but deny the evolutionary theory. The former leads to a withdrawal from the realist commitment *per se*, whereas the latter casts doubt on scientific realism as it rejects one of the most mature scientific theories we have had. Therefore, structural realism as a variant of scientific realism fails vis-à-vis the EDA against scientific realism.

CHAPTER 3

ENTITY REALISM VIS-À-VIS THE EDA

In the previous chapter, it is shown that Structural Realism is a target of de Ray's EDA insofar as it relies on the metaphysical intuition. This chapter explores whether another prominent position within scientific realism, entity realism, also becomes a target of this EDA. This is crucial to the current discussion, as de Ray's EDA is put forward as a global argument against scientific realism. To assess this, the arguments for entity realism are first presented. Then, the strength of the position against the EDA is weighed. To accomplish this, I will address two different interpretations of entity realism and argue that the first interpretation is a target of the EDA, while the second interpretation provides good reasons against it. The moral of this chapter will be to defend that entity realism in its putative interpretation is not a victim of the EDA - which means that scientific realism *tout court* cannot be said to be a target of the EDA.

3.1. Arguments for Entity Realism

Although it spans different branches and topics of science, it is worth remembering that one of the most important elements of the dispute between scientific realists and anti-realists concerns the unobservable entities of science. Non-selective realists can subscribe to both the theories and the unobservable entities of the mature sciences, but selective positions such as structural realism and entity realism generally subscribe to one of these two. In contrast to structural realists, entity realists argue that scientific realism is not a defensible position with respect to the theoretical

elements of science (e.g., theoretical laws, theoretical explanations, etc.), but only with respect to a realist commitment limited to some entities.

Here the emphasis on "some" is important. According to entity realists, not all theoretical entities deserve a commitment to their reality. In fact, this position is also called *instrumental realism* because it argues for a commitment to belief in the existence of those theoretical entities that can be systematically manipulated and instrumentalized under certain experimental conditions. To elucidate this central thesis of the position, we will examine the arguments of Ian Hacking and Nancy Cartwright, the two most prominent and earliest proponents of this position.

In his book *Representing and Intervening*, Ian Hacking argues for an "experimental argument" for scientific realism (Hacking, 1983: 265). According to him, experimental work in science provides evidence for realism with respect to some theoretical entities. Hacking, however, objects to the traditional way of dividing scientific objects into real and unreal ones according to the criterion of observability. This is because, the ability to observe depends on a continuum ranging from seeing with the naked eye to seeing through a microscope, thanks to advances in scientific equipment. Theoretical entities that were once considered unobservable, such as genes, are now perfectly observable (Hacking, 1983: 170). Therefore, theoretical entities should not be equated with unobservables.

For Hacking, the criterion for the reality of theoretical entities is their *manipulability*. The idea is that, we can have a reasonable belief in the existence of certain theoretical entities as long as they are used as instruments for *generating* new phenomena under concrete experimental conditions. Moreover, this kind of manipulation is possible by interacting with them, thanks to our knowledge of low-level causal properties or home-truths about these same entities. “Experiment is the creation of phenomena” (Hacking, 1983: 229).

Given these criteria for realist commitment, entity realism's approach to scientific theories resembles that of instrumentalist anti-realists. Theories are viewed as mere intellectual tools for understanding phenomena, and are used to some extent to construct experimental setups. Hacking does not deny that theories are integral to the

experimental side of scientific practice. Nevertheless, he emphasizes, “It remains the case, however, that much truly fundamental research precedes any relevant theory whatsoever” (Hacking, 1983: 158).

Note that this experimental argument does not resort to the No-Miracles argument, which is a very typical feature of many realist positions. Indeed, Hacking's approach runs carefully counter to the realist argument from explanatory success. The emphasis of the entity realist argument is that, unlike IBEs, the existence of the entity in question is not postulated to explain the phenomenon, but is necessary to produce the phenomenon itself.

> The argument […] is not that we infer the reality of electrons from our success. We do not make the instruments and then infer the reality of the electrons, as when we test an hypothesis, and then believe it because it passed the test. That gets the time-order wrong. By now we design apparatus relying on a modest number of home truths about electrons, in order to produce some other phenomenon that we wish to investigate (Hacking, 1983: 265).

> However it is always admissible, at least for philosophers, to treat inferences to the best explanation in a purely instrumental way, without any commitment to the existence of entities used in the explanation. But it is now seventy years after Milikan, and we no longer have to infer from explanatory success. Prescott et al., don’t explain phenomena with electrons. They know a great deal about how to use them (Hacking, 1982: 83).

This is why Hacking's interpretation of experiment as *the creation of new phenomena* is so crucial: phenomena, as the results or effects of experiments, are not things that happen out there in the world waiting to be discovered and explained. Rather, the phenomena in the laboratory that prove the existence of the theoretical entities in question are created by manipulating those very entities. Let us take an example from Hacking himself: In the PEGGY-II experiments, electrons are manipulated to produce the phenomenon of parity violation in the weak neutral current interaction (Hacking, 1982: 84) – an evidence for the existence of the entities we call "electrons."

Nancy Cartwright also argues for entity realism in a similar way and at a similar time to Hacking. However, there is a slight yet complementary difference between these two: While Hacking's defense relies heavily on the creation of new phenomena in the experimental context, Cartwright's derives support from the legitimacy of the inference in causal explanation in its opposition to IBE. Although her *How the Laws of Physics Lie* (1983) is devoted primarily to a critique of *the facticity view* of laws from a theory-antirealist standpoint, it also paves the way for entity realism as well.

"If the laws of physics are to explain how phenomena are brought about, they cannot state the facts" (Cartwright, 1983: 73). This is the dictum of Cartwright's theory-antirealism. According to the facticity view of laws, which can be associated with most positions of scientific realism and especially with its structuralist variant, scientific laws are true if they explain the obtaining of facts successfully. For Cartwright, however, theoretical laws are in fact *false* because they are incapable of correctly describing the very real facts' obtaining in particular situations and circumstances. Unlike the *ceteris paribus* ideal conditions of the theories, the composition of causes prevails in the real world.

> Most scientific explanations use *ceteris paribus* laws. These laws, read literally as descriptive statements, are false, not only false but deemed false even in the context of use. This is no surprise: we want laws that unify; but what happens may well be varied and diverse. We are lucky that we can organize phenomena at all. There is no reason to think that the principles that best organize will be true, nor that the principles that are true will organize much (Cartwright, 1983: 52-53).

The rejection of the facticity view of laws has a corresponding effect on the approach to scientific theories and explanations accordingly. Remember that presupposing the facticity view was the reason why structural realism failed in the face of the EDA, as it implied that facts have explanations for their obtaining and laws provide us with the true explanations for the structural relations of the factual world. Nonetheless, according to Cartwright, just as it is according to the instrumentalist antirealists, explanatory success does not *simpliciter* entail truth. Like Pierre Duhem and Bas van

Fraassen[2], she believes truth is an *extra ingredient* or *characteristic* of an explanation (Cartwright, 1983: 89, 91). The upshot is that, a theory's or explanation's success in accounting for or saving the phenomena gives justification only for believing that it is successful or that it saves the phenomena and nothing more than that—i.e., it doesn't justify believing that it is true. And since inference to the best explanation (IBE) is the attribution of truth to the best explanation at hand, it is invalid and illegitimate for the reasons just stated.

Yet, Cartwright argues that the situation is different for the causal explanations that theoretical entities provide: "Arguments against inference to the best explanation do not work against the explanations that theoretical entities provide. These are causal explanations, and inference from effect to cause is legitimate" (Cartwright, 1983: 89). Causal explanations present us with the concrete causes of concrete effects. That is, the existence of the cause is an *internal characteristic* of a causal explanation, whereby truth is "built into" it (Cartwright, 1983: 91). While acceptance of an IBE does not necessarily entail a commitment to its truth, acceptance of a causal explanation necessarily entails a commitment to the *existence* of the very cause.

> What I invoke in completing such an explanation are not fundamental laws of nature, but rather properties of electrons and positrons, and highly complex, highly specific claims about just what properties of electrons and positrons, and highly complex, highly specific claims about just what behavior they lead to in just this situation. I infer to the best explanation, but only in a derivative way: I infer to the most probable cause, and that cause is a specific item, what we call a theoretical entity (Cartwright, 1983: 92).

Certainly Cartwright, like Hacking, limits the realist commitment only to those theoretical entities that can be mentioned in specific experimental contexts. Moreover, this recourse to the logic of causal explanation supports the experimental story Hacking uses in favor of theoretical entities. It seems that while Cartwright emphasizes the legitimacy of inferring the existence of the cause from the effect in

[2] Cartwright discusses these two philosophers' antirealist arguments in detail in *How the Laws of Physics Lie* (1983). For the detailed versions of their arguments see Piere Duhem, *The Aim and Structure of Physical Theory* (1962) and Bas C. Van Fraassen, *The Scientific Image* (1980).

causal explanations, Hacking emphasizes the necessity of the cause to create the effect through manipulation.

Just as there is a structural realist argument to save realism in the face of pessimistic meta-induction, i.e. of radical theory-change, by pointing to the structural similarities of theories, entity realists also have a strategy to defend a continuum between successive theories despite their theory-antirealism. And this continuum derives its rationale from *the causal theory of reference*.[3]

According to both Hacking and Cartwright, the theoretical entities worthy of believing in their existence on the basis of the criteria discussed earlier are not the entities of a particular theory *per se*. Rather, they are the concrete entities with which we have come into contact in the experimental setup, thanks to a causal interaction between them and us (or our apparatuses)—the operation which fixes the references. As for the various theories about the same entity, it remains the case that they merely ascribe correct or incorrect properties to the same entity in question. The following two quotations from Cartwright and Hacking illustrate this point.

> But note that the electron is not an entity of any particular theory. In a related context van Fraassen asks if it is the Bohr electron, the Rutherford electron, the Lorentz electron or what. The answer is, it is the electron, about which we have a large number of incomplete and sometimes conflicting theories (Cartwright, 1983: 92).

> Bohr, Schrödinger and Milikan were all talking about electrons. They had different theories about electrons. Different stereotypes of electrons have been in vogue but it is the reference that fixes the sameness of what we are talking about (Hacking, 1983: 81).

[3] In short, causal theory of reference is a semantic view which defends that the reference of the terms is fixed by a direct causal interaction between the speaker and the object. In this theory of reference, although the descriptive knowledge attributed to the object changes over time, the term still refers to the same object irrelevantly once the object is identified as such. For theoretical entities, the causal interaction for fixing the reference is the experimental manipulation. For Hacking's discussion of Putnam's causal theory of reference in its relation to entity realism, see Hacking (1983: 75-91).

Thus, compared to theoretical explanations, which are IBEs, causal explanations with theoretical entities legitimately justify realist beliefs in the existence of these theoretical entities. Therefore, scientific realism, with agnosticism towards theories and realism restricted only to the existence of theoretical entities, is argued to be a defensible position given the combination of Hacking's experimental and Cartwright's causal argument in its favor.

3.2. Entity Realism: A Target of the EDA?

Let us state again the central ideas of de Ray's EDA against scientific realism. The argument states that scientific realism depends on the acceptance of IBE. And the reason for this was that, since scientific theories and explanations were products of IBE, scientific realism was also committed to IBE as well. Moreover, the No-Miracles argument was also an IBE because it inferred the truth of realist philosophy as it stood as the best explanation for the success of science. This inference of truth from explanatory success hinged on the metaphysical intuition that facts generally have explanations for their obtaining. For, it presupposed that a fact taking place must also have *the* objective and profound explanation of its obtaining, indicating that if the explanation is successful then it must thereby be *the* true explanation.

Ultimately, the evolutionary skeptical argument was directed against this metaphysical intuition on the grounds that, as a method of belief formation, it would not provide our ancestors with a fitness-enhancing advantage, since the behaviors required for survival were just as compatible with being intuitive empiricists. The skeptical argument thus holds that the reliability of the metaphysical intuition has no explanatory power for our reliance on it—i.e., that our continued reliance on this metaphysical intuition is unjustified, rendering scientific realism to undermine itself.

Let us now take the underpinnings of entity realism to see if it also becomes a target of the EDA against scientific realism. The two immediate concerns are whether entity realism depends on the No-Miracles argument and thus on IBE. The other concern is whether it depends on a metaphysical intuition of the sort that de Ray questions.

I argue that there can be two different interpretations of the entity realist argument, one of which leads it to be a potential target of the EDA, while the other strengthens it with a different strategy. The first interpretation is based on the idea that inferring existence from causal explanation, as opposed to IBE, is legitimate. I refer to this as the *Legitimate Inference* interpretation. The second interpretation, on the other hand, excludes inference altogether and conjugates the proof of existence directly to instrumentalization. Now, call this the *Tool-Based* interpretation. First, I will interpret the entity realist argument in the *Legitimate Inference* way and address some problems this interpretation poses in terms of susceptibility to the EDA. Then, I will show that retaining the *Tool-Based* interpretation can help entity realism free itself from such entanglements.

3.2.1. The Legitimate Inference Interpretation of Entity Realism

First, the *Legitimate Inference* interpretation. Recall the argument Hacking puts forward for entity realism. Hacking emphasizes that the existence of the theoretical entities is not inferred from the success of science, but from their manipulability in the experimental setup to create new phenomena. As Hacking mentions, there is a difference in terms of temporal priority in the two types of explanation (Hacking, 1983: 265). In the case where existence is inferred from the success of the explanation featuring the very entity, a belief in the existence of the entity is only formed after the obtaining of the fact or the phenomenon. However, in the case where the entity is used as an instrument to create the phenomenon, the belief in the existence of the entity, thanks to our ability to manipulate it, precedes the obtaining of the phenomenon. Consequently, the belief in the existence of the entity is temporally prior to the obtaining of the phenomenon in the entity realist inference, in contrast to IBE where the obtaining of the fact is temporally prior.

In de Ray's argument targeting IBE, the formation of the explanation and the belief in the truth of the explanation follows the obtaining of the fact, so it is a post-factum presupposition that the fact *must have* the kind of explanation just given. In Hacking's argument, belief in the existence of the entity, along with some home-truths about it, is not post-factum. The very possibility of the fact itself depends on the existence of the entity in the first place. "[…] we no longer have to infer from

explanatory success" (Hacking, 1982: 83). This is a very practical argument for realism. The metaphysical intuition that facts generally have explanations for their obtaining does not underlie the realist beliefs in question. Rather, it is the case that some facts *do* indeed have explanations for their obtaining, since their obtaining is practically made possible by the very reality of some theoretical entities. We infer the existence of, for example, the electron, from our ability to instrumentalize and manipulate it in the process of creating the phenomenon of the parity violation in the weak neutral current interaction. That is, we do not simply infer it from the existence of some phenomenon.

Cartwright's causal argument points to this very fact about the inference to the existence of the cause. Recall her distinction between IBE and causal explanation. The distinction hinged on the place of the truth in its relation to the structure of the explanation. In IBE the truth was external to the explanation, while in causal explanation truth was internal to it. Consequently, the inference was illegitimate in the former whereas legitimate in the latter. Explaining the phenomenon as the concrete effect of a concrete cause entails the commitment to the existence of the cause and the causal properties that bring forward this effect, if the explanation is accepted because it is successful or correct. Notice that here we are not simply ascribing truth independently, as in the case of theoretical explanations. Rather, we are saying that such-and-such an entity caused such-and-such a phenomenon by such-and-such of its properties in such-and-such a situation.

In this interpretation, we should take the entity realist argument to be essentially a combination of the arguments of Hacking and Cartwright. According to this reading, Hacking argues that we infer the existence of the unobservable theoretical entity from its instrumentalization in the creation of the new phenomenon. What Cartwright adds to this picture is the legitimacy of this inference in the experimental context, as distinct from the theoretical one.

However, de Ray may still say that this argument also depends on the metaphysical intuition that facts generally have explanations for their obtaining. For, it presupposes that the fact as an effect should have a cause for its obtaining, and this is still a presupposition that there is *the* explanation or *the* cause of the fact, whether the

explanation is causal or not. In any case, we still make an *inference,* and this kind of inference is still problematic as it ultimately relies on the metaphysical intuition.

Indeed, in its *Legitimate Inference* interpretation, the entity realist argument has some implications that might make it vulnerable to such attacks. Although Hacking is explicitly against a No-Miracles reading of his argument, while emphasizing that inferring entities doesn't depend on the scientific success, the argument nevertheless is open to such a reading. For example, Margaret Morrison (1990) argues that Hacking's argument can be interpreted as depending on IBE. For, it can be argued that the argument infers the existence of entities as an explanation for experimental success: "the existence of the entities provides the only explanation of successful engineering" (Morrison, 1990: 17). Morrison suggests that since Hacking boldly resists interpreting his argument as a success argument, it is better to conceive it as a transcendental argument that presupposes the existence of entities as a necessary condition for the possibility of experimental practice. Nonetheless, the idea is that Hacking's experimental argument falls short of demonstrating that experimental results prove the truth of the belief in the existence of entities.

> In other words, 'doing' does not imply the truth of theoretical presuppositions that accompany the 'doing' (i.e., that entity *x* exists and we have correctly understood its causal properties). Nor does it necessarily provide evidence for the truth of these presuppositions (Morrison, 1990: 18).

Given the *Legitimate Inference* interpretation, then, one can argue that the existence of the entities is inferred as the best explanation for experimental success—e.g., that electrons exist because their existence explains why we have been successful in experimentation by manipulation. This is to the detriment of entity realism, because this is an IBE and thus the metaphysical intuition is at work here as well. De Ray's EDA might argue that we can do successful engineering without investing in a realist explanation for what we do, simply by being instrumentalists about experimentation as well.

On the other hand, Cartwright's argument is not free of similar weaknesses. The point that directly attracts attention is her strict distinction between IBE and

inference from causal explanation, from which Cartwright derives the legitimacy of inferring the existence of theoretical entities. On closer inspection, however, the distinction is not as clear as she suggests. Matthias Egg argues that Cartwright's criterion of non-redundancy for causal explanations is subject to the *conventionality objection* (Egg, 2012: 270-271). The objection is as follows. If the multiplicity of theoretical explanations can be reduced to a single explanation that survives after experimental testing, then this theoretical explanation is suddenly regarded as a causal explanation. That is, what we differentiate as causal is not essentially a distinct kind of explanation, but a label given to a theoretical explanation *post factum*—making the demarcation between theoretical and causal explanation not a matter of redundancy but of tolerance to redundancy. Egg concedes that:

> Unfortunately, this way of interpreting the requirement of non-redundancy does little to defend entity realism against the conventionality objection, because it makes the causal/theoretical distinction depend on our attitude towards redundancy, which is just as much a matter of convention as our habit of taking "causally explains" (but not "theoretically explains") as a success term (Egg, 2012: 271).

Thus, inference to the most likely cause is on a par with the IBE. One could argue that giving the best causal explanation is still giving the best explanation even though the existence of the entity featuring in the explanation is internal to the explanation itself. As long as the possibility of redundancy is not completely and logically ruled out in causal explanations, there is also the redundancy of the entities whose existence is internal to each explanation. In view of this, inference to the most likely cause also relies on the metaphysical intuition that facts generally have *the genuine* causal explanations for their obtaining.

These two objections to the entity realist argument, which speak for its engagement with IBE and the metaphysical intuition, renders the position incapable of resisting the EDA against scientific realism. Therefore, entity realism in its *Legitimate Inference* interpretation is a target of the EDA.

3.2.2. The Tool-Based Interpretation of Entity Realism

Now, I will present the *Tool-Based* interpretation of entity realism.[4] One caveat: this interpretation applies only to Hacking's argument for entity realism and not to Cartwright's. I will explain why this is the case after presenting the interpretation. So from now on, I will refer specifically to Hacking's argument for entity realism when I use the term "entity realism".

In this interpretation, entity realism does not argue for existence on the basis of explanations and inferences. Rather, the argument is straightforward: the proof of existence is the very practical use of entities in experimentation and manipulation. If we can use and manipulate them as tools, then they are real. Or, in Hacking's words, "if you can spray them, then they are real" (Hacking, 1983: 23). No further explanation or inference is needed to justify their existence.

Boaz Miller (2016) discusses that Hacking's argument for entity realism can be interpreted in five different ways.[5] According to his last interpretation, the *Non-Argument Interpretation*, Hacking actually provides no argument for the reality of entities and the laboratory practice is the direct proof of existence (Miller, 2016: 1004). My *Tool-Based* reading and Miller's *Non-Argument Interpretation* are similar in this respect. He states that:

> The last interpretation of Hacking's argument is that it is not an argument at all, as Hacking does not think that an argument can establish the reality of electrons. Rather, the experimental practice directly illustrates their reality. According to this interpretation, the epistemic warrant for ER lies in directly perceiving the laboratory practice, rather than any feature of an argument for it (Miller, 2016: 1004).

An objection to this kind of interpretation could be that, although it is a pragmatic argument, we still have to infer the existence of entities, since we cannot directly

[4] I am deeply grateful to Professor William Giles Wringe for evoking this idea.
[5] The five interpretations that Miller (2016) argues are as follows, respectively: a no-miracle argument, an indispensability argument, a transcendental argument, a Vichian argument, and a non-argument. However, I will not get into details of the first four interpretations.

detect them through observation. Ultimately, we cannot prove that there is such an entity and therefore we have to rely on inference.

However, this objection assumes that the criterion of reality and existence is *observability*. This is why the dispute about theoretical entities is widely held to be a matter of dealing with the unobservables that we cannot see directly. Nonetheless, one may doubt that the criterion of reality should be observability. In fact, this might be another metaphysical intuition which is not warranted at all. Given the *Tool-Based* interpretation of entity realism, the criterion of reality can rather be defined as manipulability or instrumentalization. We know that the hammer exists simply because we use it to hammer nails. We know that electrons exist because we use them to produce the parity violation in weak neutral current interactions.

According to this reading, an entity ought not to be an object of a certain kind of explanation to be worthy of arguing for its existence. Insofar as there is the mediation of an explanation, there is an inference in the putative sense de Ray talks about. But if this condition of existence is denied on the grounds that we do not need to present an explanation for the existence of an entity, and if the question of existence is conjugated to that of a simple practical engagement, the problem of inference is also abolished altogether. We do not infer the existence of electrons from the experimental result; we know that the electrons exist because we use them to create the experimental outcome.

Still, the objection can insist on asking how we know that what we are using in the experiment is electrons. Obviously, we are using *some* thing, but to claim that what we are using is electrons is a further inference. But I believe this objection has a problem: It begs the question against the Tool-Based Interpretation. For, as discussed above, it presupposes that the concept of being fundamentally relies on observability; hence we are always obliged to make inferences to argue for the existence of the putative unobservable.

To resolve the issue, we should understand the ticklish difference. Let's take that *E* is our conclusion, that there are electrons. While making an inference, there is more to inference than merely having the putative conclusion. Inference requires an extra

justificatory argument for its conclusion, i.e., an argument for why we are accepting *E*. What the practicing scientists do when they believe *E* is not this. They believe *E* because they practically spray the electrons. Here, there is no justificatory argument for why they believe *E*. Regardless of whether the experimental results are successful or not, the question of whether electrons exist does not arise for the practicing scientists. If the experiment fails, it is due to other reasons, not due to the nonexistence of the putative entity. Scientists cannot make sense of the idea that they are using an entity as a tool without believing that the entity they are using as a tool exists. In this sense, while believing *E*, scientists don't make inference, they just spray the electrons.

As for how they can be sure that the unobservable things they use are actually electrons, I think Hacking's argument already addressed that. For, remember, he argues that the scientists are able to use the electrons because they built the putative experimental instruments to use them with some home truths about them. In a sense, the instruments are already set to work if there are any electrons at all. Therefore, they know that the entities they are spraying are electrons. But why should we believe that the electrons exist? We believe it on the basis of the testimony of the practicing scientists. Scientists inform us that they are doing something with the electrons, and we believe what they tell us as the practitioners of science.

For someone who is not convinced with this "non-argument" way of the Tool-Based interpretation, another alternative that involves an evolutionary perspective can be formulated. The alternative way is to reread the Tool-Based argument by engaging inference again in the argument, however excluding the problematic metaphysical intuition that facts generally have explanations for their obtaining. This alternative can be formulated as follows. We have evolved to be tool-using creatures as distinct from most of the other animals. Therefore, we are quite competent at picking out things that we can use as tools. Moreover, when we are using something as a tool, we are able to latch onto something in reality. Because, if we were not able to latch onto things in reality by our tool-use, then we wouldn't be able to survive. In other words, we can say that our tool-use by itself attests to the fact that we are making some real changes in the external world. Consequently, in our tool-use, there is still the inference about the existence of the things we are using. However, this time, the

inference does not derive from the problematic metaphysical intuition that facts generally have explanations for their obtaining. Rather, it derives from the idea, or if you like, the intuition, that we have evolved to be competent at picking out tools, i.e., to latch onto reality for our survival.

In this way, I think we can still speak of inference but differently than the way de Ray opposes. In either reading of the Tool-Based interpretation, entity realism has a way out of engaging in the problematic metaphysical intuition, and thus of becoming a target of the EDA against scientific realism.

As for Cartwright's argument for entity realism, the *Tool-Based* interpretation does not apply, since her argument specifically relies on the legitimacy of inference in causal explanations. However, as argued, as long as the argument for realism depends on an inference, Cartwright's argument cannot be immune to the EDA because there is still the problem of redundancy in causal explanations. Consequently, to save realism from IBE and the metaphysical intuition that facts generally have explanations for their obtaining, the entity realist argument should aim at the simple pragmatic defense which is present in Hacking but not in Cartwright.

Recall the discussion in the first chapter—the discussion over what it takes to be a scientific realist. Given de Ray's construal of scientific realism as "the view that our best scientific theories accurately represent real, mind-independent states of affairs" (de Ray, 2022: 971), it seems doubtful in what sense entity realism is *really* a version of realism. In this discussion over realism, I remarked on the three aspects of the realist commitment, to whom different versions of scientific realism commit to a certain extent: metaphysical, semantic, and epistemic commitment. Given these commitments as the criteria of scientific realism, to what extent entity realism passes as a version of scientific realism?

I believe that entity realism is committed to all these three dimensions of realism, but since it is exclusively very experimentally-oriented and theory-aversive, it doesn't seem to be so in the first stance. The metaphysical commitment prescribed that realism is a belief in the mind-independent existence of the world. Now, compare the

entity realist argument. Entity realism, given its final interpretation here, advocates that there are entities out there in the world, some of which we cannot observe but come into causal contact with. The semantic commitment said that scientific claims should be taken at face value, i.e., either as true or false. Although entity realism can be interpreted as antirealist, agnostic, or instrumentalist toward scientific theories and high-level theoretical knowledge, remember Hacking's argument for the manipulation of the entities: we are able to implement the experimental setup and to manipulate the entity through some home-truths we have about the very entity. In other words, at least some scientific claims (which can be narrowed down to very pragmatic concerns) are taken at face value. As for the epistemic commitment, that scientific theories give the knowledge of the world in the sense that they are approximately true and the entities they posit do partake in the world, although entity realism denies the former dimension it agrees on the latter one. It acknowledges that the entities worthy of realist commitment after experimentation are of course posited via certain theories. However, it denies a commitment to those theories thereby which the entities are posited. Given these, I think entity realism has all the rights to be classified as scientific realism, as one of its selective ones.

All in all, given this *Tool-Based* interpretation of Hacking's entity realism, the problem of IBE and the metaphysical intuition is ruled out while arguing for scientific realism. This shows that there is at least one version of scientific realism that is not the target of the EDA that de Ray puts forward against scientific realism.

CONCLUSION

Scientific realism one more time faced a new challenge. This time, the challenge was to account for realism in the face of an evolutionary debunking argument. The argument put a Darwinian Dilemma for the realist: either she must accept the implication of the evolutionary theory for our innate metaphysical intuition and withhold the realist commitment, or she must keep the realist commitment and reject the evolutionary theory's implication. The conclusion was a global one: scientific realism fails in the face of this EDA.

Against this bold conclusion, I dissected whether this is the case with the different variants of scientific realism. To achieve so, in the second chapter, I focused on structural realism. Both in its epistemic and ontic versions, structural realism turned out to be relying on IBE and thus on the unjustified metaphysical intuition. Later, in the third chapter, I assessed entity realism to see if it also engages in IBE and the metaphysical intuition. I offered the Tool-Based interpretation of entity realism, and argued that interpreted in this way, it can bypass the problem of inference and the metaphysical intuition altogether. Ultimately, the general conclusion of my thesis is this: While scientific realism in its structuralist variant becomes a target of the EDA, given a specific interpretation of its entity realist variant, it can survive the threat of being debunked as such.

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