PEIRCE AND SCIENTIFIC REALISM

A PEIRCIAN CONTRIBUTION TO CONTEMPORARY DEBATES IN PHILOSOPHY OF SCIENCE

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Submitted to the faculty of the University Graduate School
in partial fulfillment of the requirements
for the degree
Master of Philosophy
in the School of Liberal Arts
Indiana University

January 2022

Accepted by the Graduate Faculty, Indiana University, in partial fulfillment of the requirements for the degree of Master of Philosophy.

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DEDICATION

To my friends, Soner Gerbağa and Mustafa Kutlubay, who interrupted my dogmatic slumber.

ACKNOWLEDGEMENT

I would like to acknowledge and give my warmest thanks to my supervisor, Prof. Cornelis de Waal, who made this work possible. His guidance and advice carried me through all the stages of writing my thesis. I would also like to thank my committee members for letting my defense be an enjoyable moment, and for your brilliant comments and suggestions, thanks to you. I would like to thank Prof A. Ayhan Çitil, who has always inspired and encouraged me to pursue my career in philosophy. He also read my thesis and gave me insightful comments and suggestions.

I am extremely grateful to my parents, Ayten and Ihsan, for their love, prayers, caring and sacrifices for educating and preparing me for my future. My sincere thanks also go to Sven Christiansen and his family, for offering me to stay at their house. I am also very much thankful to my fiancée, Edibe Feyza Güney, for her love, understanding, and continuing support to complete this thesis. Without her help and support, the completion of this thesis could not have been possible.

I would like to thank my friend, Murat Şamil Şen, whose friendship is beyond everything. He also read my thesis several times and discussed all the arguments of it with me. I cannot describe the joy of discussing my ideas with a philosopher.

Finally, my thanks go to all the people who have supported me to complete my thesis directly or indirectly.

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Scientific realism and antirealism are two main views in the philosophy of science regarding the status of unobservable entities in science and whether we have good epistemic reasons to believe that our current successful scientific theories are (approximately) true. Briefly, the former claims that our scientific theories are (approximately) true and unobservable entities these scientific theories postulate exist. On the other hand, the latter claims that we do not have good epistemic reasons to believe that our scientific theories are (approximately) true and that unobservable entities our scientific theories postulate exist. The scientific realism has two primary tenets, one axiological (i.e., science should seek truth) and the other epistemological (namely, our current successful theories are (approximately) true). In this thesis, the issue has been examined from standpoint of the account of Peirce's philosophy of science, more accurately based on his understanding of reality, truth and basic idealism. In the first chapter, I outline the main points of the debate from the perspectives of both sides. In the second chapter, I give reasons why the scientific realists' argument is not convincing. In the third chapter, I attempt to draw an accurate picture of the account of Peirce's views on the nature of scientific theories. In the last chapter, I make a case for scientific realism from the Peircean account of philosophy of science. I have claimed why the current debate cannot be settled without accepting a kind of Peirce's basic idealism and his understanding of reality. I think both scientific realists and antirealists accept a kind of

naïve realism. This is the main reason why it is not possible to settle the debate from their standpoints. In order to overcome this issue, I attempt to develop a more sophisticated realism based on Peirce's understanding of reality, truth and basic idealism.

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INTRODUCTION

The prestige of scientific knowledge and methods is beyond words nowadays. Of course, it comes as no surprise to hear that. After all, we all enjoy the benefit of the outcomes of scientific inquiry in almost all parts of our lives. For instance, meteorologists make accurate forecasts of the weather. Thanks to their predictions, you do not get wet in the rain (assuming you do not forget to watch a weather channel). You can easily communicate with another person from the other part of the world via a cellphone or the Internet while sitting in your living room. What is more, scientists can predict whether a giant asteroid will hit the Earth. If so, they can destroy it before it hits the Earth. Lewens expresses the success of the sciences mentioned above more dramatically as follows, "[t]he achievements of the sciences are extraordinary. They have produced explanations for everything from the origins of human culture to the mechanisms of insect navigation, from the formation of black holes to the workings of black markets" (Lewens, 2016, p. xiii). It goes without saying that all the predictions that scientists make, their achievements more generally, are based on current scientific theories. Unsurprisingly, after witnessing its accurate predictions and more, one is inclined to think that these current scientific theories must be true. Otherwise, we would not be able to explain these successes that scientific theories have. This is, roughly speaking, the argument of the scientific realists, who think some successful current scientific theories are (approximately) true and that the entities they refer to exist. I believe that this attitude is the most common one among both scientists and well-educated people.

However, historians of science tell us that many successful scientific theories later turned out to be false. For example, "[m]any…theories featured theoretical terms, such as

'phlogiston', 'ether' and 'caloric'…which, according to modern science, fail to refer to anything at all" (Ladyman, 2002, p. 231). The reader who is familiar with these terms from the history of science may already notice that theoretical terms, such as 'phlogiston', 'ether' and 'caloric' were supposed to refer to unobservable entities. It is not hard to notice that many of our current scientific theories feature some unobservable entities such as electrons, protons and the like. We cannot observe them with the unaided eye. Therefore, we cannot be sure that our current scientific theories are (approximately) true. Accordingly, we cannot claim the existence of unobservable entities that scientific theories postulate. Roughly speaking, this is one of main arguments of the scientific antirealists known as 'pessimistic meta-induction'.

One may ask, so what do we mean when we say that we do not observe entities such as electrons with the unaided eye? We can still observe them with an advanced microscope, can we not? This was exactly the reaction of one of my friends, who is well-educated and holds a PhD degree, had when I told him that my master's thesis is roughly about whether atoms exist, he was surprised and asked me "do we not still observe them?" I assume that this will be most people's reaction when someone tells them that we do not have good (epistemic) reasons for saying that unobservable entities that our current theories postulate exist.

So far, we encountered two problems: the first is whether our successful current theories are true or not, and the second is whether unobservable entities postulated by scientific theories exist.

The main aim of the present thesis is to clarify these two problems and seek answers to questions (problems) using Peirce's philosophy of science. Briefly, what

makes Peirce important in this debate is his belief that "ideas are not "out there" waiting to be discovered…and ideas are produced not by individuals, but by groups of individuals…" (Menand, 2002, p. xi). Let me explain this a little bit.

Most philosophers are realists though they have different ontologies. As they differ in their ontologies, so does their understanding of reality. The question, what are the limits of reality? prompts philosophers to the compelling inquiries of 'what is there and what is not'. This includes a discussion on the status of unobservable entities and whether we have good reasons to believe that some of our successful current theories in science are (approximately) true.

There are different schools of thought that favor different understandings of reality in contemporary philosophy of science. One of those schools is the "realist" or "scientific realist" school, among the proponents of which are the majority of scientists from scientific communities. According to this group of people, scientific theories are true or truth-like and their constituents, whether they are observable or not, are real. Another school consists of people who claim that one's answer to the question, "what is there?" must be cast in one's concrete experiences and some of these people, such as van Fraassen, are called "empiricists". According to the adherents of this second school of thought, names in scientific theories have merely nominal value and we cannot epistemically claim that unobservable entities are real. Both schools agree on the fact that the discussion is an epistemological one.

The main argument of the first group (scientific realists) is that the "predictive power" of scientific theories is an undeniable fact and as a direct result of that either we have to accept that there is the reality these theories postulate or that we must

acknowledge “miracles”. Rather than accepting miracles, to think that scientific theories represent reality is considered more reasonable. The second group, on the other hand, holds that epistemologically the only way to speak of the reality of an entity is an empirical one, and that therefore the claim that there are unobservable entities scientific theories postulate is epistemically not possible.

Looking at the names given to both sides of the discussion, one may get confused. While the phrase “scientific realism” implies a name of an ontological school, van Fraassen’s “constructive empiricism” suggests a name of an epistemological school. In the history of philosophy, realist is contrasted with anti-realist, whereas empiricist is contrasted with rationalist. In fact, what lies at the heart of the issue is that “truth” (an epistemological problem) and “reality” (an ontological problem) are inseparable like the two sides of the same coin. That is to say, there is an inextricable bond between what kind of the understanding of reality we have and what kind of understanding of truth we hold.

The major problem for the discussion is that it remains stuck within a narrow framework. To develop new approaches to the discussion, the history of philosophy can be taken as an example. Epistemological debates in modern philosophy have been overcome through idealist philosophy. Both empirical and rationalist epistemologies have a common ground in that both have an understanding of reality and truth independent of an agent—the one who knows. Taking into account that in idealist philosophy “reality and truth” are based on a knowing agent, it seems that empirical epistemology stands with rationalist epistemology against idealism. A similar approach can be adopted to overcome the current discussion. Peircean pragmatism provides a helpful conceptual

framework to the discussion, as it leaves out the metaphysical burden of idealism[1] and at the same time preserves the achievements of idealism through the idea of intersubjectivity.

According to Peirce, reality is in a state of being/processing and the ideas and theories of those who know that reality are also parts of that state of being.

By taking into account an understanding of truth based on intersubjectivity and an understanding of reality compatible with it, it becomes possible to speak of the reality of unobservable entities, which is an important aspect of the current discussion. On top of that, it also allows us to abandon the no-miracle argument.

In the first chapter, I discuss the main arguments on both sides, namely, the scientific realists and antirealists, and explain why I am bringing Peirce into this debate. Scientific realism has two tenets: one is that science seeks truth, and the other is that some of our scientific theories are (approximately) true. My conclusion of this chapter is roughly that scientific realism is more of an attitude than a philosophical doctrine. Therefore, in order to defend the tenets of scientific realism, we need a better argument. In other words, I propose that we keep the tenets of scientific realism and defend them within the perspective of a Peircean account of philosophy of science.

In the second chapter, I summarize the main aspects of the history of philosophy of science and the nature of scientific theories in the twentieth century. I have done this because many influential philosophers of science (e.g., Thomas Kuhn, Paul Feyerabend and Larry Laudan) argue that the aim of science is not seeking truth, and that we do not

[1] As Lane puts it, Peirce's basic idealism "…is very different from Kant's transcendental idealism, which denies that our thoughts can represent reality as it is in itself, from Hegel's and Royce's forms of absolute idealism, which posit the reality of an absolute mind, and from Berkeley's ontological idealism, which denies that there are real external things" (Lane, 2007, p. 70).

have good epistemic reasons to believe that some of our current scientific theories are (approximately) true. These are serious attacks on both of the tenets of scientific realism.

In the third chapter, I reconstruct a Peircean account of scientific method in order to defend the tenet of scientific realism that 'science seeks truth'. Peirce thinks there are four ways of fixing beliefs, but the method of science is the only one that can provide 'permanently settled opinions' for us. I will give reasons why there are four methods. Then, in order to show why the other methods do not provide us with 'permanently fixed opinions', I spent some time showing their weaknesses. I am proposing that Peirce's understanding of the nature of scientific theories is compatible with the understandings of some twentieth-century philosophers of science discussed in the second chapter. Therefore, if we accept Peirce's conception of science, we can still insist that science seeks truth despite the objections raised in chapter 2.

In the fourth chapter, I mainly deal with Peirce's understanding of reality and his basic idealism with an eye to finding a solution to the problem of the existence of unobservable entities that our scientific theories postulate. I will propose that it is plausible to claim that we have good epistemic reasons to believe that we can know whether unobservable entities scientific theories postulate exist in the Peircean sense.

The conclusion of this thesis is that we should maintain the tenets of scientific realism while rejecting how these tenets have been argued for because this argument has been mostly rendered implausible by scientific antirealists' counterarguments. In its stead, a new approach has been proposed to defend these tenets from a Peircean understanding of reality and truth, and his basic idealism.

CHAPTER 1: THE REALISM-ANTIREALISM DEBATE IN PHILOSOPHY OF SCIENCE

In the present chapter, I will discuss the main aspects of the debate on scientific realism and its opponents in detail and give reasons why this debate has not been settled by scientific realists. Scientific realists claim that our successful scientific theories are (approximately) true. They defend this claim based on the no-miracle argument which is one of the most well-known arguments for scientific realism, and the argument claims that our current scientific theories are (approximately) true because of their successful predictions and applications. As for antirealism, there are two main accounts, one of which is about the nature of scientific theories, namely, Laudan's view, the other one is constructive empiricism formulated by van Fraassen. Both views deny the claim that we have good epistemic reasons to believe that our successful scientific theories are (approximately) true. More precisely, they argue that truth or falsity does not apply to scientific theories because they believe that science does not seek truth. In what follows, I shall outline the main parts of the debate, show why the debate is mainly epistemological, and finally explain why what we understand by reality is the key element of the discussion.

The philosophical debate regarding appearance and reality goes back to the beginning of ancient times. Thinkers have always pondered the nature of things. Some (e.g., Plato, Parmenides) have thought the appearance is illusive while others (for instance, Hume) have claimed that there is nothing to know behind the appearance. With the developments of modern science, especially after Newtonian physics, some philosophers like Comte did not believe the existence of some objects of science on the ground that we are not able to directly observe them. However, in nineteenth-century,

unlike Comte, scientists had no doubt about the ether. They thought it was just like atoms and other theoretical entities. Atoms, ether, molecules "could not be directly observed and indeed diehard positivists rated them as nothing more than convenient notions for correlating observation, but most scientists took them to be as real as ordinary objects such as tables and chairs…" (Trusted, 1991, p. 156). Nowadays, it seems that no scientist believes in the existence of the ether. However, atoms and molecules have been able to save their status among the scientific community so far. In the early twentieth century, it was completely legitimate for many philosophers to doubt whether there are such things as atoms. "But 'in due course, after Hiroshima especially, it ceased to seem plausible to question the existence of atomic particles" (Rescher, 1987, p. 1). In what follows, we reexamine the problem of the existence of atomic particles and see whether we have good (epistemic) reasons, as scientific realists maintain, to believe in the existence of unobservable entities or as scientific antirealists maintain, all we have is just some empirically successful applications of theories such as atomic theory.

The distinction between appearance and reality is also one of the most controversial issues among the contemporary philosophers of science. The problem is that common sense tells us a different story from what science says about the world. We can see this dilemma in the book of the physicist Arthur Eddington, *The Nature of The Physical World.* He starts his famous book with discussing the distinction between appearance and reality. He believes that there are two tables. One of them belongs to our ordinary world. It is an ordinary object. We all are well familiar to it. We use it almost every day in our homes, offices, and libraries. However, the other is 'scientific table'. As Eddington put it,

> It is a more recent acquaintance and I do not feel so familiar with it. It does not belong to the world previously mentioned-that world which spontaneously appears around me when I open my eyes, though how much of it is objective and how much subjective I do not here consider (Eddington, 2007, p. ix).

Our scientific table consists of atoms. Atoms consists of electrons, protons which are unobservable. But scientists obtain the knowledge of those unobservable entities by using scientific methods. According to Eddington, modern physics also tells us that it is the only scientific table which is real. In other words, the world described by science implies that "common-sense reality is an illusion" (Ladyman, 2002, p. 130). The more physics became abstract, the more commonsense reality[2] became an illusion. As a result, theories like quantum mechanics and superstring theory have taken us away from commonsense reality. So, there are two realities: one is scientific antirealism which says the ordinary table exists and the other is scientific realism which claims that the table described by science exists. One may object to this distinction by claiming that these two tables are not that different. We can accept both tables. But Eddington warns us that when a physicist deals with physical problems, he must abandon the idea of the ordinary table and just accept the scientific table.

Some philosophers like Paul M. Churchland are inclined to think the world described by science gives us the reality. Churchland does not see any difference between scientific knowledge or theoretical knowledge such as theoretical understanding of molecules, atoms and common-sense or non-theoretical knowledge like our knowledge of tables, pens and the like. He thinks "our common-sense conceptual framework stands

[2] In this thesis, I will use common-sense reality and common-sense realism in the scientific realism/antirealism context. More specifically I will use it for van Fraassen's position. As a matter of fact, van Fraassen himself claims that "[c]onstructive empiricism is indeed set squarely within a common sense realism…" (van Fraassen, 2003, p. 479). Of course, it would be a mistake to think that van Fraassen is a commonsense philosopher like Thomas Reid.

unmasked as being itself a theory, or a battery of related theories" (Churchland, 1979, p. 2). He goes as far as to say that all of our knowledge is theoretical, including perceptual knowledge as well. In his article, "*Eliminative Materialism and The Propositional Attitudes"*, he says that "our commonsense conception of psychological phenomena constitutes a radically false theory, a theory so defective that both the principles and the ontology of that theory will eventually be displaced…" (Churchland, 1981, p. 67). On the other hand, antirealists like van Fraassen defend commonsense reality[3] and stay agnostic regarding the existence of unobservable entities. Accordingly, we can classify two main approaches concerning scientific theories: scientific realism and antirealism. Now I will take a close at look what these main two philosophical views are.

The first account is scientific realism. Scientific realists believe that without committing to the idea that realism is true, we cannot have a proper picture of science. In this context, what scientific realists mean by 'true' is a kind of correspondence theory of truth. Scientific realists usually argue that we can attain both knowledge of the observable parts of the world and the unobservable parts of the world. So, we can say that

> [t]here are two kinds of scientific realism, one for theories, and one for entities. The question about theories is whether they are true, or are true-or-false, or are candidates for truth, or aim at the truth. The question about entities is whether they exist (Hacking, 2010, p. 26-27).

According to scientific realism, the limits of scientific knowledge go beyond what we can directly observe with the unaided eye. Scientific realists believe that their philosophical position is so obvious that one can be convinced easily when she or he considers what our current scientific theories are about. For instance, in biology,

[3] Of course, antirealists are not commonsense philosophers, but in this debate, at least van Fraassen is inclined to defend commonsense realism when it comes to the existence of unobservable entities.

biologists talk about microorganisms which are not seen with the naked eye; in physics, physicists talk about subatomic entities such as quarks; in astronomy, scientists talk about unseen planets in our universe, just to name a few. To scientific realists, since our best scientific theories give us a great range of facts about the world, we have good reason(s) to believe that they are (approximately) true. Let me summarize the argument (the no-miracle argument) behind this claim.

As Hilary Putnam put it, "I believe that the positive argument for realism has an analogue in the case of mathematical realism. Here too, I believe, realism is the only philosophy that doesn't make the success of the science a *miracle*" (Putnam, 1975, p. 73). This argument is known as 'the no-miracle argument' and thought to be "inference to the best explanation".[4] The no-miracle argument is as follows: we have successful theories in science, and we make empirical predictions by using those theories. What makes these successes rational (or not a miracle) is the claim that at least our successful (or best) theories are (approximately) true. Accordingly, if our theory of atoms posits the existence of electrons, protons, quarks etc., and if this theory makes some extraordinary successful predictions, then the atomic theory must be (approximately) true. Otherwise, those successes would be miraculous. In other words, some of our current successful scientific theories are incredibly successful when it comes to predicting, manipulating and participating "…in worldly phenomena, and the most straightforward explanation of this is that they correctly describe the nature of the world, or something close by" (Chakravartty, 2007, p. 4). Because belief in the existence of external objects is 'the

[4] Some scholars (for example, Richard Boyd) assume that no-miracle argument is an example of abductive reasoning in the Peircean sense. However, this is a misunderstanding of Peirce's abduction (see Mcauliffe, 2015).

necessary condition for science' and scientific realists claim that we can obtain true knowledge of these external objects, they commit to some philosophical tenets which will be mentioned below.

A scientific realist usually commits to three philosophical views. She commits to the existence of a mind-independent world of observable and unobservable entities. Speaking roughly, what we mean by 'unobservable entities' here is the entities that we are not able to observe with a naked eye. "Scientific realism involves a metaphysical [ontological, T.A] commitment of a similar nature to Eddington's table No. 2; electrons, genes and other unobservables are part of a mind-independent world" (Ladyman, 2002, p. 138). This is a metaphysical (ontological) commitment.

Since she (a scientific realist) claims our scientific theories describe correctly the external world, she also accepts a correspondence theory of truth, and she believes that we should interpret scientific theories literally. In other worlds, statements about unobservable/theoretical entities "should be taken at 'face-value'" (Horwich, 1982, p. 182). When a scientific theory claims that the material world consists of atoms, then we should accept that atoms exist. They are basic building blocks of every existent thing. In other words, we should not interpret them as theoretical terms or tools. This is the semantic commitment of scientific realists.

Last but not least, she has an epistemological commitment as well. That is, "…we can know that our best current theories are approximately true, and that they successfully refer to (most of) the unobservable entities they postulate, which do indeed exist" (Ladyman, 2002, p. 159). These are simply what a scientific realist commits to. It goes without saying that if one commits to the last one, then, she/he automatically accepts the

other commitments. To illustrate this, if a person thinks our best current theories (approximately) true, and they successfully refer to unobservable entities these theories postulate, from these we can conclude that this person believes in the existence of the world outside us and we successfully obtain the knowledge of this world and finally our statements about this world refer to the objects of this world.

However, one should keep in mind that even though it seems scientific realism is a doctrine, "[i]t is more an attitude than a clearly stated doctrine. It is a way to think about the content of natural science" (Hacking, 2010, p. 26). Accordingly, even though scientific realists do have an epistemological stance (for instance, the no-miracle argument is epistemological) in this debate, it is hard to classify them in any epistemological stance. This is why, in the debate, they are just called realists or scientific realists. However, van Fraassen calls his account 'constructive empiricism' which implies his epistemological position. To illustrate why scientific realism is not a doctrine, I will make use of the idea of Searle's default positions. He thinks "default positions are the views we hold prereflectively so that any departure from them requires a conscious effort and convincing argument" (Searle, 1999, p. 9). To him, accepting the existence of a real world that is independent from us, accepting that we perceive this world directly with our senses, accepting that most words in our language successfully refer to real objects in the world, and accepting that "our statements are typically true or false depending on whether they correspond to how things are, that is, to the facts in the world" (Searle, 1999, p. 10) are some of the most common default positions in our ordinary everyday lives. Searle claims that these views or presuppositions are 'the background of our thought and language' and as he points out, "much of the history of philosophy consists in attacks on

default positions" (Searle, 1999, p. 10). For instance, scientific antirealism denies most of these views when it comes to believing the existence of unobservable entities scientific theories postulate. Needless to say, these views are exactly what scientific realists defend in the philosophy of science. I think 'naïve realism' mainly consists of these views I quoted from Searle. I will say more about this issue later in the fourth chapter. Now I will explain why scientific antirealists do not agree with scientific realists.

So far, so good. One may wonder why antirealists do not agree with the plausible view of scientific realism. After all, some sciences such as physics and chemistry are concerned with physical world and thus theories of physics and chemistry must be about this physical world. As Russell put it, "A scientific opinion is one which there is some reason to believe is true; an unscientific opinion is one which is held for some reason other than its possible truth" (Russell, 2001, p. 5). However, this view is controversial now in the active philosophical debate. In the contemporary debate within the philosophy of science, while realists proclaim that our best scientific theories correctly give us not only the knowledge of observable entities of the world but also the knowledge of unobservable entities of the world, antirealists deny that our scientific theories describe unobservable entities correctly.

Needless to say, the contemporary debate between realists and antirealists has been about the status of unobservable entities scientific theories postulate in science, especially over the last few decades. To date there has been little disagreement on what the status of observable entities[5] in science is. In everyday life, we are familiar with the

[5] This is not surprising because antirealists like van Fraassen are empiricists. On the other hand, scientific realists do not see any difference between observable and unobservable entities in terms of being objects of science.

observable entities such as tables, chairs, books etc. We perceive those objects without using any instruments like telescopes. However, we all know there are other things we cannot perceive with our unaided senses. For example, there are many satellites (or moons) of Jupiter we can observe only with an advanced telescope. Of course, if we were close enough to them, we would be able to see them without any instruments. However, when it comes to observing microorganisms, this is not the case. We must use an optical microscope in order to (arguably) observe those tiny little organisms. Although "scientists manipulate things like atoms and invisible radiation when they design microchips and mobile phone networks" (Ladyman, 2002, p. 130), some philosophers (e.g., van Fraassen) think that we do not have epistemic good reason(s) to believe in the existence of these entities.

Van Fraassen insists on the fact that no one can see a microscopic organism with a microscope. To him, all we see is an image. On the other hand, he holds the idea that we can see through a telescope. Unlike microscopic so-called entities, we can approach that telescopic object and in theory, see it with naked eyes. Therefore, "It is important to clarify that, as a constructive empiricist would use the terminology, one only observes something when the observation is unaided" (Monton & Mohler, 2019). Of course, there are different kinds of microscopes such as electron microscopes and optical microscopes. Both require certain theoretical commitments, but in the case of the former they are much more far reaching; One could argue that an optical microscope is just an extension of a magnification glass, with which we can see that what is seen through the glass is the same as what lies behind it. But that is much harder in the case of an electron microscope and other advanced microscopes. However, van Fraassen does not see any difference

between them. As I said above, he separates telescopes just because, at least theoretically, it is possible for us to approach telescopic objects and see them with our own eyes. “A look through a telescope at the moons of Jupiter seems to me a clear case of observation... But the purported observation of micro-particles in a cloud chamber seems to me a clearly different case…” (van Fraassen, 1980, p. 16-17).

In the current debate, scientific antirealism is the account that denies at least one of these commitments mentioned above. For instance, Laudan believes that we do not have (epistemic) good reasons to claim that our successful current theories are (approximately) true. He denies such a claim on the basis of his meta-inductive argument which mainly says that just as historically many empirically successful scientific theories proved false, so will our current successful theories. I will say more about this argument when discussing the nature of scientific theories in the next chapter. On the other hand, van Fraassen does not accept the epistemological claim regarding unobservable entities scientific theories conjecture, as well as staying agnostic regarding the metaphysical commitment to the existence of unobservable entities. He stays agnostic because he thinks that all evidence is observational and, therefore, we cannot know anything beyond our observations. He thinks that our theories *can* be committed to the existence of the postulated unobservable entities. But this does not mean that we *should* be committed to. In this way, while he shares logical positivists’ epistemological stance, he does not hold logical positivists’ semantic claim that talking about unobservable entities is meaningless.

It seems that the main problem between scientific realists and antirealists is essentially epistemological. Let me give some examples to support this opinion. For instance, Churchland argues that common-sense reality, just like scientific realism, is

merely a theory and we should replace common-sense realism with scientific realism. He thinks we need to discuss the issue epistemologically. As he puts it, "…the real climax occurs when we pursue these considerations into epistemology" (Churchland, 1979, p. 6). As already mentioned above, both Laudan and van Fraassen reject the epistemological commitment of scientific realism. This is why van Fraassen calls his position constructive empiricism. This indicates that he thinks the debate is essentially epistemological. One of the contemporary philosophers, Timothy Lyons, also thinks that the current debate regarding scientific knowledge is mainly epistemological. As Lyons puts it, "[c]ontemporary scientific realism consists of two primary tenets, one axiological and the other epistemological" (Lyons, 2005, p. 167). The axiological view is the idea that science seeks truth. On the other hand, the epistemological view is the idea that "our successful scientific theories have achieved (or approximated) this goal" (Lyons, 2005, p. 167). Lyons goes as far as to say that "… epistemic realism has yet to make its case… in fact, I'd suggest that we have good reasons to at least treat theoretical truth as epistemically utopian" (Lyons, 2005, p. 168). Another philosopher who thinks that the real issue is epistemological is James Laydman. According to him, contrary to common opinion that philosophers discuss the existence of ordinary objects, he claims that "the real philosophical problem is not to find out if everyday objects exist, or even if we know that they do, but rather to explain *how* we can know that they exist and what their nature is" (Ladyman, 2002, p. 138). When it comes to believing in the existence of unobservable entities scientific theories postulate, the attempt to explain *how* we come to know that they exist and what their nature is *is* what makes the problem more important in the epistemological sense.

At this point, we need to clarify what makes Peirce important for this debate. There are two main points which makes Peirce important for the debate. The first one is Peircean pragmatic epistemology. As already mentioned, the real issue between scientific realism and its opponents is primarily epistemological. Van Fraassen is an empiricist, whereas scientific realists such as Churchland are anti-empiricists. In the traditional sense, the debate would be between empiricism and rationalism. But scientific realists are unwilling to call themselves rationalists. I assume this is because of metaphysical burden of rationalism. Peirce came with a third option, namely, a pragmatic epistemology. As we will see, the Peircean position sheds light on the current debate. Besides this, the advocates of scientific realism tend to hold a correspondence theory of truth. However, most of philosophers of science (Thomas Kuhn, Laudan etc.) abandon any kind of correspondence theory of truth in the scientific inquiry. From a Peircean pragmatic epistemology, it will be proposed that it is still possible to talk about the truth of scientific theories and thereby the existence of unobservable entities our scientific theories postulate.

The second one is Peirce's account of what reality is. Although we call one side of the debate 'realist' and the other one 'antirealist', but both sides defend an ontological realism. However, antirealism like van Fraassen's realism is based on commonsense realism while the other side's realism is based on scientific realism. For van Fraassen, the real table is Eddington's table No. 1, while for Churchland, the real table is Eddington's table No. 2. As for Peirce, he defends a kind of realism based on his basic idealism. It will be proposed that unobservable entities are real in a Peircean realism.

Consequently, as we have seen, the debate consists of two issues, one of which is whether we have good epistemic reasons to believe that scientific theories are true, the other is whether unobservable entities these theories postulate exist. It seems that scientific realists hold a correspondence theory of truth and believe that our successful scientific theories regarding unobservable entities refer to unobservable entities of the world. This is the reason why they believe in a kind of naïve realism. However, as will be seen in the next chapter, most of philosophers of science have abandoned the idea that our scientific theories are (approximately) true. They say that the history of science is full of refuted theories which used to be empirically successful. This is a big challenge for scientific realists to handle. With respect to the second issue, scientific antirealists reject the idea that we have good (epistemic) reason to believe that the unobservable entities scientific theories postulate exist. In the next chapter, I will deal with the first issue in detail. As for the second issue, I will deal with it in the fourth chapter.

CHAPTER 2: THE NATURE OF SCIENTIFIC THEORIES

In the present chapter, what the nature of scientific theories is will be discussed. As mentioned in the previous chapter, scientific realists like Churchland hold the claim that our scientific theories can provide us with the true picture of the world. As a result, scientific realists go a step further and claim that some current scientific theories are (approximately) true. As indicated in the previous chapter, "[t]ruth is understood... as a correspondence relation" (Sankey, 2008, p. 3). However, as will be seen below, most of the philosophers of science in twentieth century have abandoned the idea that scientific theories represent the true picture of the world. For instance, Laudan's pessimistic meta-induction argument brings both the epistemological tenet and the axiological tenet of scientific realism into doubt. Therefore, if scientific realists are not able to defend these tenets, it will be implausible to meaningfully make the discussion about whether unobservable entities scientific theories postulate exist. So, I will outline the main objections to the axiological tenet of scientific realism in the present chapter. I believe that even after these objections, we can hold the axiological tenet in a Peircean sense. In a broader sense, the debate concerning what the nature of scientific theories is, at bottom, closely relevant to the demarcation problem. To discuss some solutions of this (demarcation) problem will prepare the ground for our main discussion of what the nature of scientific theories is.

In the twentieth century, the focus of philosophy of science was the problem of what science is. In other words, the demarcation of science from non-science was one of the main problems for philosophers of science (Hansson, 2019). The problem is important because the privilege of science is widely accepted, and it is reasonable to ask

what makes science so special among other intellectual endeavors such as metaphysics. The early years of twentieth century was when the logical positivism was the dominant philosophical school in the English-speaking world. Logical positivists held that science was totally rational and as a result of that, it was objective. According to logical positivists, scientific theories must be empirically confirmed. Logical positivists claim that "[o]bservation and experiment is a neutral foundation for scientific knowledge…" (Ladyman, 2002, p. 96). They claimed that when two scientific theories do not agree on an issue, all scientists need to do is comparing these theories with observational facts and make their decision accordingly. They also saw a sharp distinction between theoretical terms and observational terms. They asserted the claim that statements about theoretical terms are meaningless, because they thought that we do not experience them with our senses. For them, "a statement is literally meaningful if and only if it is either analytic or empirically verifiable" (Ladyman, 2002, p. 151). The logical positivists, moreover, usually neglected the history of science when they explained theory change in any science.

However, as Popper has shown, some tenets of logical positivists are implausible. For instance, the confirmation or verification of theories is not a feature of scientific theories. What is more, Popper claims that confirmation and verification are not even possible. Scientific theories can only be falsifiable. For him, falsification is the demarcation of science. In other words, what makes a theory scientific is that it must be falsifiable. For Popper, Freud's psychoanalysis is not scientific because we are not able to falsify it. Apart from this, Popper agrees with logical positivists on ideas of the fact that science is cumulative and, as mentioned above, there is a sharp demarcation between

scientific theories and non-scientific endeavors, and "[t]here is an epistemologically crucial distinction between the context of discovery and the context of justification" (Ladyman, 2002, p. 95). Later Kuhn, in his famous book *The Structure of Scientific Revolutions* (1962), would disagree with almost all of these ideas.

Kuhn, in his book, develop a fresh perspective to the evaluation of theories. He was mainly concerned with the nature of scientific revolutions such as the Copernican revolution in astronomy. He thought that the biggest mistake of both logical positivists and Popperians is that they were not taking history of science into account when they tried to explain the nature of scientific inquiry. He coined the term 'scientific paradigm', a term widely used in philosophy of science today. According to him, a paradigm is a system of "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners" (Kuhn, 1996, p. x). A paradigm consists of theoretical assumptions and a set of 'exemplars,' by which Kuhn means some solved problems by means of the paradigm's theoretical assumptions. For instance, Ptolemaic astronomy was a paradigm. Kuhn claims that scientific communities always work in a scientific paradigm providing 'model problems' and solutions to the scientific community. He called this stage 'normal science'. During the periods of normal science, when a paradigm reigns supreme, scientists are dogmatic or conservative. Normal science is puzzle-solving. Scientists tend to not abandon their theories even there are many anomalies. He disagrees with a Popperian account of falsification. He thinks falsifying a theory is not enough for scientists to abandon the theory. There are always anomalies. "However, sometimes scientists become aware of anomalies that won't go away no matter how much effort is put into resolving them" (Ladyman, 2002, p. 101). Also note

that scientists cannot abandon the old paradigm, even when there are significant anomalies, unless there are new insights that point in a new direction, i.e., there are at least significant beginnings toward a new paradigm. He calls this 'paradigm shift' or revolution.

In this new paradigm, scientists find themselves in a new world and they abandon problems of the old paradigm and start working on new problems. According to Kuhn's understanding of paradigm shift, science is not just based on abstract processes and objective, logical measures, as logical positivists maintain. Science should also be understood in both the social and historical contexts. In other words, "this means that scientific change cannot be properly understood without taking account of social forces" (Ladyman, 2002, p. 105). This is a big challenge for both logical positivists' and Popperian understanding of theory change in science. Because Popper claims that when a theory is refuted, scientists abandon that theory. However, as Kuhn has shown, to abandon or adopt a theory requires more than just refuting or confirming it. Scientists start questioning the dominant paradigm and eventually abandon a paradigm when the paradigm in question has lost its problem-solving efficiency, not because when it is falsified. Some philosophers of science like Lakatos later objected to some of Kuhn's ideas.

Lakatos "presented his philosophy of science as the upshot of an historical sequence of philosophers" (Hacking, 2010, p. 113). In other words, he established his philosophy of science by modifying logical positivists', Popper's and Kuhn's philosophies of science. He thought that Kuhn's philosophy of science makes science irrational. He claimed that "Kuhn's reduction of philosophy of science to sociology…left

no place for the sacrosanct scientific values of truth, objectivity, rationality and reason" (Hacking, 2010, p. 112). Lakatos replaced Kuhn's paradigms with 'research programmes' which have positive and negative heuristic. The positive heuristic guides scientists about important problems and the negative heuristic keeps scientists away from questioning some principles of research programme. If some theories in a research programme predict some novel facts, the programme is progressive. If they do not, the programme is degenerating. A degenerating programme can be progressive in the future. Therefore, we should not abandon a research programme easily. But on Lakatos' view, scientists never know when they abandon a research programme for good. As Hacking put it, Lakatos' methodology of research programmes looks "…like an account of rationality, but is rather an explanation of how scientific objectivity need not depend on a correspondence theory of truth" (Hacking, 2010, p. xii). Laudan rejected Lakatos' philosophy of science and came up with a new one. While he was doing this, Laudan accepted some parts of Lakatos' philosophy of science and established his own philosophy of science.

In his widely known book, *Progress and Its Problems,* Laudan claims that "[s]cience is essentially a problem-solving activity" (Laudan, 1978, p. 11). In other words, the aim of scientific theories is nothing but solving problems. To him, there are empirical and conceptual problems scientists want to solve. Whenever scientists have solved a problem (this problem can be either empirical or conceptual), there will be scientific progress. But this progress does not indicate that science is cumulative. He agrees with Kuhn and Lakatos on the idea that scientists work on scientific problems under a paradigm/research program/research tradition. He claims that research traditions provide "a set of guidelines for the development of specific theories" (Laudan, 1978, p.

79). For instance, when a scientist commits to Cartesian physics, then, what exists for him is just matter and minds. So, he cannot accept that particles can interact by action-at-a-distance.

As can clearly be seen from the ideas of philosophers of science mentioned above, most of philosophers of science have given up the claim that scientific theories are (approximately) true. Popper denied that our scientific theories are inductively confirmed. Nevertheless, he held that our scientific theories are approximately true. But Kuhn rejected this idea on the ground that when a paradigm is changed, scientists abandon its problems and they commit to a new paradigm, this means that they study a new world. On the other hand, Lakatos tried to show that our scientific knowledge grows "whatever we think about 'truth' or 'reality'" (Hacking, 2010, p. 119). When it comes to Laudan, he not only denies that we have good epistemic reasons to believe the claim that our current scientific theories are (approximately) true, but also develops an argument against it. As this background knowledge should suffice us to pursue our next discussion, now let us see what this argument says.

The well-known argument against the no miracle argument is the 'pessimistic meta-induction' argument proposed by Larry Laudan. According to Laudan, "… many nonrealists have been nonrealists precisely because they believed that false theories, as well as true ones, could have true consequences" (Laudan, 1984, p. 134). In other words, in order to show why the no miracle argument is false, Laudan proposed an argument that claims that it is not an enough reason for a theory to be (approximately) true just because it makes some correct empirical predictions. The argument goes as follows: in the history of science there were several successful theories that were nonetheless refuted. Our

current successful theories are like those refuted theories. Therefore, it is plausible to think that many of our current successful theories will be refuted in the future. Therefore, we do not have any good justification to believe they are (approximately) true. In addition, theories such as Newtonian mechanics are still widely used and still successful in many respects. But we all know it is false. As Lyons points out, it should be kept in mind that Laudan's argument does not say that "*our present theories are probably false*" (Lyons, 2002, p. 65). The argument is essentially about the justification of our beliefs.

It is clear that Laudan's pessimistic meta-induction is successful. But what it demonstrates is that the success of a theory is not a criterion to believe the theory to be true. In other words, it shows us that our past theories were false, and our current theories are, in essence, like the refuted theories and this means current theories are also likely false. This does not necessarily indicate that they are false or that they, in the future, will be proven to be false. It seems it is safe to say that success is a necessary but not a sufficient condition for us believe whether a theory is true or false. Of course, although the argument is arguably successful, we should not conclude from the history of science that the destiny of our current theories will be like the refuted theories. "We should not think that this question is one to be settled solely by the historical track record. We might have reason to believe that our methods of hypothesizing and testing theories have improved over the years." (Godfrey-Smith, 2003, p. 178). As we have discussed in the first chapter, the pessimistic meta-induction argument is a convincing one against the no-miracle argument. But it does not logically indicate that all kinds of scientific realism are implausible. Or rather, it is a big challenge for the version of scientific realism described in the first chapter. But it is not a challenge for the version of scientific realism Hacking

proposes in his book, *Representing and Intervening*. In this book, Hacking suggests that we should give up the idea of the fact that our scientific theories represent the true picture of the world. Nevertheless, to him, we can still accept the existence of unobservable entities postulated.

In order to save the no-miracle argument, some realists (e.g., Jarrett Leplin and Stathis Psillos) have modified their argument and claimed that some of the constituents in successful theories which are responsible for a certain successful prediction the theory made are approximately true, "… while certain past successful systems, taken as wholes, may fail to be approximately true (by present lights), certain postulates contained within them nonetheless been retained" (Lyons, 2006, p. 538).[6] With this new modification, the no-miracle argument can be summarized as "a theory's success would be miraculous if those constituents that had a genuine bearing on its successful predictions were not (at least approximately) true" (Lyons, 2006, p. 538). Even with this subtle modification, the no-miracle argument still does not seem immune to the attacks of the historical argument (pessimistic meta-argument). Because, here there is another problem as well, namely, the problem of the incommensurability of scientific theories.

This view ('that some of the constituents of successful theories which are responsible for a certain successful prediction the theory made are approximately true') contrasts sharply with Kuhn's account of the incommensurability of scientific theories which claims that "…successive and competing theories within the same domain 'speak

[6] This position is not new. We can see this idea in Russell's book, *The Scientific Outlook*. As David Papineau put it in the preface of the book,

> … no serious scientist will ever hold that some current scientific theory is exactly true. Still, it does not follow that existing theories are downright wrong. After all, when Einstein's relativity theory replaced Newton's classical physics, Newton was not totally rejected, but rather shown to be less than fully accurate. Similarly, future theories will show our current theories, not to be totally mistaken, but rather to be approximately right (Papineau, 2001, p. ix).

different language'. They cannot strictly be compared to each other nor translated into each other" (Hacking, 2010, p. 66). According to this view, what Aristotle understands by the term 'motion' is mainly different from what nowadays physicists understand by the word. "…[T]he proponents of competing paradigms will often disagree about the list of problems that any candidate for paradigm must resolve. Their standards or their definitions of science are not the same" (Kuhn, 1996, p. 148). Therefore, in the Aristotelian physics, concepts refer to different things and say, in the Newtonian system, they refer to something else. Naturally, their list of problems is mostly different as well. As Kuhn put it,

> must a theory of motion explain the cause of the attractive forces between particles of matter or may it simply note the existence of such forces? Newton's dynamics was widely rejected because, unlike both Aristotle's and Descartes's theories, it implied the latter answer to the question. When Newton's theory had been accepted, a question was therefore banished from science. That question, however, was one that general relativity may proudly claim to have solved (Kuhn, 1996, p. 148).

This means that the number of questions in science is changeable. What is more, in a new theory, scientists leave some questions unsolved, which means those questions are no longer problems for the new theory. Therefore, some of the constituents in successful theories cannot mean or refer to the same things in the new theories.

In the light of the discussion made above, it is clear that most of philosophers of science have abandoned the idea that scientific theories represent the true structure of the world. So, it is safe to say that they have also abandoned a correspondence theory of truth. Neither Kuhn nor Lakatos accept that scientific theories represent the true picture of the world. In addition, both Kuhn and Laudan think the aim of science is just puzzle-solving or problem-solving. They do not see any difference between scientific problems

and intellectual problems as well. It seems to me that taking these developments into account, the epistemological commitment of the scientific realism is implausible. In other words, the claim that our current successful theories are (approximately) true is under attack by the pessimistic meta-induction argument. As mentioned above, some scientific realists such as Hacking agree with antirealists on the idea that the epistemological commitment of the scientific realism is untenable.

However, I do not think this means that scientific antirealists won. Of course, these challenges mentioned above make the scientific realism unacceptable. Still, in this thesis, I will propose a modest scientific realism from a Peircean perspective. As it will be seen, taking all these developments in the philosophy of science into account, Peirce's account of scientific inquiry provides us with a pragmatic picture of science that allows us to talk about the truth of scientific theories even though Peirce's understanding of truth is different from that of scientific realists. Now let us take a close look at what Peirce thinks about the nature of scientific theories in the next chapter.

CHAPTER 3: PIERCE AND THE NATURE OF SCIENTIFIC THEORIES

This chapter takes a close look at Peirce's philosophy of science to determine whether a Peircean account of how science works is still plausible today. As we saw in the previous chapter, some of the most famous philosophers of science abandoned the idea that scientific theories are (approximately) true. As I indicated in the last part of the previous chapter, Peirce's account of scientific inquiry provides us with a pragmatic picture of science that allows us to talk about the truth of scientific theories even though Peirce's understanding of truth is richer than that of scientific realists. It has dual-aspect; representationalist and investigative. This is why I discuss Peirce's idea of truth and reality before addressing his account of scientific inquiry and what he says about the nature of scientific theories. In order to show that Peirce's account of scientific inquiry is still plausible, even after taking most of the considerations discussed in the last chapter into account, we need to examine what Peirce understands by scientific inquiry.

What is science, according to Peirce? First, he does not agree his contemporaries or dictionaries which define science as "systematized knowledge". To him, knowledge itself, no matter how systematized, 'may be a dead memory',

> …our notion of science should be a notion of science as it lives and not a mere abstract definition…science is a pursuit of living men, and that its most marked characteristic is that, when it is genuine, it is in an incessant state of metabolism and growth (Peirce*,* 1998, p. 129).

Nor does he define science according to its method. As de Waal puts it, "according to Peirce, when in our inquiry we are inspired by the scientific attitude, this will cause us to develop or appropriate the methods we need" (de Waal, 2014, p. 104-105). This means scientific methods are changeable and context specific; particle physics

may call for different methods than epidemiology or forensic anthropology. We will return to this issue later. Let us first try to grasp what science is, according to Peirce.

The quotation from de Waal's book partially gives away what science—or, more specifically, the sciences of discovery[7]—is for Peirce. As Peirce put it, "…what I mean by a "science…is the life devoted to the pursuit of truth according to the best-known methods on the part of a group of men who understand one another's ideas and works as no outsider can" (Bergman & Paavola, 2017). He argues that what makes a certain enterprise a science is not the theories that have been discovered, but the pursuit of the truth by means of the best methods available at the time. In other words, "…what distinguishes science from other cognitive enterprises is not the *method* used, but the *attitude*[8] with which it is engaged in" (de Waal, 2014, p. 104). In order to understand why the scientific attitude is the demarcation of science, we need to investigate Peirce's most famous and well-read article, "The Fixation of Belief", which is mainly about the nature of science and its theories. On a side note, it is important to notice that we can see this focus on *attitude* in is not anything new. Peirce is not the only one who claims that. For instance, when Conford explained the rise of the science among the ancient Greek, he

[7] I confine this chapter to the sciences of discovery because sciences such as physics and chemistry fall under the science of discovery, for Peirce. The contemporary debate regarding the existence of unobservable entities is mainly concerned with those sciences' objects such as atoms, molecules, quarks and the like.

[8] Peirce's classification of individuals can help us to understand what he means by 'attitude'. Peirce classifies people in three groups. He claims there are mainly three kinds of people. First, there are people for whom the most important thing is 'the qualities of feelings. These people are usually interested in art. Second, he calls these kind of people 'practical' people who deal with 'the business of the world. All they respect is power. Finally, as he put it, "The third class consists of men to whom nothing seems great but reason. If force interests them, it is not in its exertion, but in that it has a reason and a law" (Bergman & Paavola, 2017). The first kind of people see the nature as picture and the second kind of people see it as opportunity and finally, the for third kind of people, it is seen as "…a cosmos, so admirable, that to penetrate to its ways seems to them the only thing that makes life worth living… and they are the only men that have any real success in scientific research" (Bergman & Paavola, 2017). As inferred from the paragraph, Peirce insists on the fact that 'the natural scientific men' are eager to learn and set themselves to comparing their ideas with experimental results in order to correct those ideas.

wrote, "...science as commonly defined: the pursuit of knowledge for its own sake, not for any practical use it can be made to serve" (Cornford, 1966, p. 5).

Since Peirce thinks that what science is "pursuing the truth by means of the best methods available in that time", I need to clarify what Peirce understands by 'truth'. In the article, "How to Make Our Ideas Clear", Peirce explains what he means by the term 'truth'. As he put it, "The opinion which is fated to be ultimately agreed by all who investigate is what we mean by the truth, and the object represented by this opinion is the real" (Peirce, 2014, p. 98). As Robert Lane points out in his book, *Peirce on Realism and Idealism*, Peirce's account of truth is 'dual-aspect'. "[I]t has a *representationalist* aspect, on which a true belief is one that represents the real world, and an *investigative* aspect, on which a true belief is one that would be permanently settled in the minds of those who use the method of science" (Lane, 2007, p. 13). The representationalist aspect of truth requires explaining the phrases 'a true belief' and 'reality' in Peircean sense.

In "The Fixation of Belief", Peirce claims that doubt is temporary and that "the irritation of doubt causes a struggle to attain a state of belief" (Peirce, 2014, p. 55), which guides our desires and shapes our habits. He calls this struggle *inquiry*. The mere aim of inquiring is the settlement of opinion or belief. At this point, he does not focus on whether the belief is true or false, "for as soon as a firm belief is reached, we are entirely satisfied" (Peirce, 2014, p. 55). In other words, at the beginning of "The Fixation of Belief", the aim of inquiry is how to fix a belief. Then, the aim of inquiry turned into how to obtain true beliefs. According to Peirce, another issue we need to point out is what the nature of belief is. Peirce thinks that belief has three properties: "…it is something that we are aware of…it appeases the irritation of doubt…and…it involves the establishment

in our nature of a rule of action, or, say for short, a *habit*" (Peirce, 2014, p. 87). As the quotation indicates, obtaining/having belief is important because we cannot act without beliefs.

Here it is important to say a few words about Peirce's understanding of doubt. As he put it, "We generally know when we wish to ask a question and when we wish to pronounce a judgment, for there is a dissimilarity between the sensation of doubting and that of believing" (Peirce, 1934, p. 370). But this is just one difference between them. He believes that another difference is practical. In doubt, we do not know what to do and we become paralyzed. This is why Peirce thinks that it is impossible to 'begin with universal doubt' as Descartes suggested. "We cannot begin with complete doubt. We must begin with all the prejudices which we actually have when we enter upon the study of philosophy" (Peirce, 1934, p. 265). Cartesian doubt cannot put our background beliefs in doubt because it is not a genuine doubt. He claims that "no one who follows the Cartesian method will ever be satisfied until he has formally recovered all those beliefs which in form he has given up" (Peirce, 1934, p. 265). We can see this in Descartes' famous book called *Meditations*. Throughout the book, Descartes regains all the beliefs he doubted at the beginning of the book. However, according to Peirce, real doubt is the doubt that causes us to lose the 'basis of conduct.' We must trust our background opinions/beliefs until we encounter some positive reasons to doubt them. This is also why radical skepticism is unrealistic.

Peirce's approach to radical skepticism is that he believes radical skeptics' doubt is not genuine. Put differently, their demand is beyond human power. However, as mentioned above, for Peirce, "[w]hat is wrong with doubt is that it leads to a paralysis of

action" (Misak, 2013, p. 33). Therefore, according to Peirce, radical skeptics would not do anything if they doubted every single belief they have. Unlike Cartesian skepticism, Peirce does not think we can doubt all our background beliefs at once just because they are not essentially permanent. In order for an inquirer to make an inquiry, "[s]ome things have to be held constant. For Peirce, the cardinal sin in philosophy is to adopt a view that blocks the path of inquiry, and the Cartesian view would stop inquiry in its tracks" (Misak, 2013, p. 34), and would do so right from the start. The Cartesian view does this (blocking the path of inquiry) by doubting every possible belief we have. Peirce believes that there are four ways of fixing a belief (opinion): the method of tenacity, the method of authority, the a priori method, and the method of science. Why there are four ways of fixing a belief is a legitimate question here. As Short claimed in his book, *Peirce's Theory of Signs*, these methods "are an ahistorical idealization" (Short, 2007, p. 331). He explains this as follow: "By the method of tenacity, the truth is what *I* believe; by the method of authority, it is what *he* tells us to believe; by the a priori method, it is what *we* find it natural to believe (truth is what is 'agreeable to reason', as many philosophers have argued); and by the scientific method, it is what experience would eventually compel us to believe" (Short, 2007, p. 332). For instance, by the method of tenacity, "one's clinging to a belief simply because it is his" (Short, 2000, p. 4). Of course, this is fictional. But it is logically possible for one to hold a belief just because it is his. I think this is a satisfying answer. Still, one may wonder why Peirce takes the trouble to dwell on these methods, rather than limit himself to the method of science only. As we will see in the following pages, each method reveals one aspect of the idea of truth. So, let us take a

closer look at these four methods in order to see why Peirce thinks we need the scientific method when we seek truth.

The method of tenacity is one of the most naïve ones. As de Waal puts it, "*the method of tenacity* is entirely defensive in nature" (de Waal, 2014, p. 96). In this method of fixing a belief, a person can take any answer he may fancy to a certain question and stays away from anything which might disturb his opinion. To illustrate this method, Peirce gives the example of an ostrich (Peirce, 2014, p. 59). The ostrich buries its head in the sand when it sees a danger. However, living in a society runs against it. A person who adopts the belief through this method will find out that there are other people who think differently from him and as a result, he will find himself in doubt again. Consequently, if we do live in a society, the method of tenacity will fail to satisfy us. As Peirce put it, "unless we make ourselves hermits, we shall necessarily influence each other's opinions; so that the problem becomes how to fix belief, not in the individual merely, but in the community" (Peirce, 2014, p. 59). This brings us to the method of authority.

The second method, which Peirce mentions in the article, is the method of authority where some communities enforce certain beliefs by using their force, propaganda and other manipulations. As we know from the history of ideas, however, no institution has ever been able to manipulate people forever. Sooner or later, this method also ends up causing some doubt:

> [A] famous example is the swinging lamp in the cathedral of Pisa that awoke the young church-going Galileo's interest in physics, an interest that was instrumental in ending the authoritatively fixed belief that the earth is unmoving center of the universe (de Waal, 2014, p. 97).

It seems that to be permanently fixed, it is not enough for a belief to be publicly enforced. "A successful method must be able to fix beliefs the contents of which are

determined impersonally–what is believed will be a result of applying the method, not decided in advance by one or more individuals before the method is applied" (Lane, 2017, p. 17). So, a true belief must be impersonal as well.

Having seen the weakness of this method, let us look into the a priori method. For Peirce, the most perfect examples of this third method can be found in "the history of metaphysical philosophy". "Systems of this sort have not usually rested upon any observed facts, at least not in any great degree. They have been chiefly adopted because their fundamental propositions seemed "agreeable to reason" (Peirce, 2014, p. 64). Euclid's axioms used to be 'agreeable to reason'. For example, the whole is greater than the part. As we already know, this axiom has been proved wrong. Therefore, the weakness of this method is that 'agreeable to reason is not stable'.[9] Some beliefs or opinions may seem unshakable right now, but they can be proven wrong in the future. As Peirce put it, the a priori method "… makes of inquiry something similar to the development of taste; but taste, unfortunately, is always more or less a matter of fashion…" (Peirce, 2014, p. 66). Like the method of authority, this method too is not able to avoid arbitrary element "[b]ecause sentiments differ from community to community, and even from person to person, and because they "will be very greatly determined by accidental causes" such as the culture and period in which one resides" (Lane, 2017, p. 18). Consequently, this method does also not guarantee a secure belief.

What the methods mentioned so far have in common is that individuals, or a group of individuals, determine what is to be believed and what is not to be believed. In

[9] Peirce's objection of the a priori method is based on his rejection of intuitive knowledge. As de Waal puts it, according to Peirce, "if we have no intuitive knowledge, then a mere inclination to believe, however strong, can never become sufficient grounds for knowledge" (de Waal, 2005a, p. 13).

other words, certain individuals or groups have a say on fixing belief or opinion. “This causes Peirce to conclude that we should seek to fix our beliefs by something that is independent of what you or I or any group in particular may think them to be” (de Waal, 2014, p. 98). As mentioned above, three methods of fixing a belief are unsuccessful because they fail to produce a fix belief, let alone a true belief. Peirce thinks that the scientific attitude can guarantee us to fix our beliefs that makes it independent of what anyone or any group may think them to be. As Lane puts it, “What… arises is the idea that in order for one’s beliefs to be permanently settled, and thus for them to be both impersonal and public, they must result from interaction with something external to anyone’s mind” (Lane, 2007, p. 19). In other words, for Peirce, given that there are only four ways of fixing belief, and the first three fail because they ignore one of the features Lane mentioned above, we are left with the fourth method, the method of science. Before investigating the scientific method, I will first explain Peirce’s idea of reality in order to better understand his *representationalist* aspect of truth.

Peirce develops his idea of three grades of clearness in “How to Make Our Ideas Clear” “The first [grade of clearness, T.A] consists in the connexion of the word with familiar experience. In that sense, we all have a clear idea of what *reality* is…” (Peirce, 1933, p.457). The second grade of clearness is abstract definition. In other words, the abstract definition of a term is the second grade of clearness. The third grade of clearness is his pragmatic maxim or “knowing what to expect if hypotheses containing the term are true” (Misak, 1991, p. 13). I will say more about these three grades below when I apply them to the term ‘reality’.

Because the method of science is based on the hypothesis that there are real things, he tries to answer how we come to know that there are any realities.[10] Peirce gives four observable outcomes of using the scientific method which imply that there are realities;

> 1 if investigation cannot be regarded as proving that there are real things, it at least does not lead to a contrary conclusion; but the method and the conception on which it is based remain ever in harmony…2 the feeling which gives rise to any method of fixing belief is a dissatisfaction at the two repugnant propositions. But here already is a vague concession that there is some one thing to which a proposition should conform…3 Everybody uses the scientific method about a great many things, and only ceases to use it when he does not know how to apply it…4 Experience of the method has not led us to doubt it, but, on the contrary, scientific investigation has had the most wonderful triumphs in the way of settling opinion (Peirce, 2014, p. 67-8).

This can be understood as the first grade of clearness in a Peircean sense. But for Peirce, the first grade of clearness of an idea is not "sufficient for the precision and logically security that is typically required in science…" (de Waal, 2014, p. 112). Still, this grade is useful. For instance, we give the first grade of clearness of the meaning of a word when someone is not familiar with the term or word we use. As mentioned, however, this grade does not give us a precise and certain meaning of terms scientific inquiry requires. This is why Peirce thinks we need the second grade of clearness of apprehension.

To repeat, even though children use the term reality with "… perfect confidence, never dreaming that [they do, T.A] not understand it. As for clearness in its second grade, however, it would probably puzzle most men … to give an abstract definition of the real"

[10] Robert Almeder in his article, "The Epistemological Realism of Charles Peirce," tries to develop an argument for Peirce's four reasons of why there are real things. He claims that "if there are no physical objects there is no Truth" (Almeder, 1975, p. 10). Because belief in the existence of external objects is a 'necessary condition for science'.

(Peirce, 2014, p.96). However, Peirce thinks he finds a perfect definition of reality, leading him to offer an abstract definition of reality in terms of Scotistic realism. Following Duns Scotus, he defines the real "as that whose characters are independent of what anybody may think them to be" (Peirce, 2014, p. 96). This definition allows us to call some mental events and mental constructions as real besides external objects. In other words, Peirce's Scotistic realism allows us to call non-existents real. For instance, a dream itself is real, but the objects we see in the dream are not real (de Waal, 2014, p. 128) because they are not independent of what anybody thinks about. Our geometrical constructions, such as triangles, in contrast are real because they are independent of what you, I or anyone may think them to be. This kind of definition achieves what Peirce calls the second grade of clearness. Unlike the first grade, the second grade helps us to define concepts. But this definition is too abstract. Peirce thinks that we can attain a 'higher grade' of clearness because abstract definitions are "disconnected from experience" (de Waal, 2014, p. 112).

Peirce's third grade of clearness is the application of what is known as the pragmatic maxim. When Peirce's pragmatic maxim is applied to this definition, what is reached is the third grade of clearness of reality. To repeat the maxim, "Consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object" (Peirce, 2014, p. 90). In his article called "How to Make Our Ideas Clear", to illustrate this maxim (rule), Peirce applied it to some concepts, such as hardness, weight and finally *reality*. When he applied the rule to the conception of the reality, this is the outcome: "The opinion which is fated to be ultimately agreed to by all who

investigate, is what we mean by the truth, and the object represented in this opinion is the real" (Peirce, 2014, p. 98). In other words, "'reality' can mean nothing *other* than the object of permanently settled belief or opinion" (de Waal, 2014, p. 130). Here Peirce not only defines what reality is but also defines what truth is. He does this because he thinks it is impossible for truth and reality to be separated (Peirce, 1934, p. 569).

Another aspect of Peirce's understanding of reality must be mentioned in order to comprehend how he distinguishes between the real and the external. It seems safe to say that "Peirce also distinguished between that which is independent of what anyone thinks *about it* – the real – and that which is independent of what anyone thinks *about anything at all*" (Lane, 2007, p. 3). According to Peirce, the former is real, but external to the mind. For instance, "…an emotion of the mind is real, in the sense that it exists in the mind…" (Peirce 1957, p. 339). Emotions are internal because they are a matter of someone's thought. As for the latter, it is external to the mind, on which no thinking has any effect (Peirce, 1934, p. 384). For example, as Lane puts it, "The earth is, in addition to being real, external, since it has the traits it has regardless of what anyone thinks, either about it or about anything else whatsoever" (Lane, 2007, p. 3). In that regard, the objects of some sciences like physics are independent in the latter sense, while the objects of some sciences like geometry are independent in the former sense. Nevertheless, all are real in the sense that they are independent of what you, I or anyone think them to be. In this regard, a character in a novel, say Raskolnikov, is not real in the Peircean sense because the features of Raskolnikov are dependent of what somebody thinks them to be. That is, without Dostoyevsky's mind, Raskolnikov would not be as he was. Accordingly, Peirce's distinction allows us to distinguish the real from the fictional.

Of course, this distinction does not imply that there are some unknowable things-in-themselves. Peirce rejects Kant's distinction between noumena and phenomena on the ground that any reality must be cognizable. "If something is real, then it can be represented in a mental state; it can be thought about, understood, cognized" (Lane, 2007, p. 59). This is what Lane calls the 'basic idealism' of Peirce. Peirce's pragmatic clarification of the idea of reality entails basic idealism which means that "reality is that which will–or on Peirce's considered view, *would*–be represented in beliefs permanently settled by the method of science" (Lane, 2017, p. 62). I will deal with the basic idealism in the fourth chapter where I discuss Peircean scientific realism. Since the pragmatic clarification of the idea of reality which relies on the investigative aspect of Peirce's account of truth entails basic idealism, I will focus on Peirce's investigative aspect of truth. In the rest of this chapter, I will be in attempt to show how the method of science works according to Peirce.

As a practicing scientist, Peirce knew that many presumed self-evident theories, when confronted with hard facts, turned out to be false. However, since the method of science is independent of anyone's' opinion, and because it is self-correcting, it can cause a permanently secure belief in the long run. What Peirce means by the fact that science is self-correcting can be outlined as follows:

> When a group of inquirers study something that is independent of what they think it to be, this independence ensures that eventually their beliefs gravitate to one another and become settled in a shared belief, assuming the inquiry continues long enough to allow this to happen (de Waal, 2014, p. 99).

So, this method takes into consideration many things that the other methods do not. Thus, whereas the first three methods leave out the impact of experience, and the method of tenacity, of authority overlook beliefs of others, and the a priori method

ignores the impact of experience, the method of science pays attention both to the beliefs of others and to the impact of experience. In other words, "as opposed to the first three methods, where human understanding sets the terms, the scientific method proceeds from the recognition that nature does not accommodate itself to our beliefs, but that our beliefs must accommodate themselves to nature" (de Waal, 2005a, p. 15). By making use of the scientific method, we gain beliefs that are caused by 'real things.' In the method of science, changes of beliefs are not merely dependent on our thinking or some authority like the Church. In short, "For Peirce, the success of science as a cognitive enterprise is based on its use of a critical, public, and self-corrective method" (Niiniluoto, 2018, p. 156). This is enough to establish the advantage of the scientific method over the other methods. Nevertheless, one should keep in mind that Peirce does not say we should get rid of the other methods (Peirce, 2014, p. 71). They are legitimate and they can be used to fix a belief. Here Peirce wants to distinguish the scientific method from the other methods, and he establishes his theory of truth.

Now, I shall examine Peirce's account of scientific method, which consists of abduction[11], deduction and induction, and show how it works in order to better understand what Peirce's account of the nature of scientific theories is.

Here I shall outline Peirce's account of the three types of inference that I just mentioned above. I will limit myself here merely to presenting them and I will interpret them in the next chapter when I discuss/develop a Peircean account of scientific realism against antirealism. Peirce claims that one of the aims of logic is the classification of

[11] Besides 'abduction', Peirce also calls this kind of the inference 'hypothesis', 'retroduction' or 'presumption'. In this thesis, the term 'abduction' is used.

arguments. He classifies inferences as either deductive/analytic or synthetic. The synthetic inferences are induction, abduction (or hypothesis) and analogy. While abduction and analogy are ampliative, deduction and induction are not. Deduction merely "…explicates what is in the premises" (Misak, 2013, p. 48). As for induction, it mainly plays the testing role in the scientific method. Induction, as Peirce put it, "never can originate any idea whatever. No more can deduction. All the ideas of science come to it by the way of Abduction. Abduction consists in studying facts and devising a theory to explain them (Peirce, 1934, p. 145)". That induction does not originate any idea is quite an interesting point which will be explained following pages.

By means of abduction we acquire new beliefs/opinions. Its logical form can be put as follows: The surprising fact, C, is observed; But if A were true, C would be a matter of course. Hence, there is reason to suspect that A is true. The conclusions of abduction are just conjectures, or hypotheses. For Peirce, abductive inference is therefore weaker than inductive inference. "Hypothetic reasoning, moreover, infers very frequently a fact not capable of direct observation" (Peirce, 2014, p. 179). To illustrate this, he states that the claim 'Napoleon Bonaparte once existed' is the conclusion of an abductive argument. Since Napoleon Bonaparte lived in the past, we do not have any chance to see/observe him. But from the historical, archaeological and other evidences, we conclude that 'Napoleon Bonaparte once existed'. It seems safe to say that our scientific claims about unobservable entities, such as photons and quarks, are obtained by abductive inference, in Peirce's sense, since these claims are hard to conceive as conclusions of inductive or deductive arguments proper. Peirce spends considerable amount of time trying to distinguish abductive reasoning from inductive reasoning. For

him, "…the essence of an induction is that it infers from one set of facts another set of similar facts, whereas…[abduction] infers from facts of one kind to facts of another" (Peirce, 2014, p. 180). Abduction plays a creative role in scientific method. In the philosophy of science, it is known as 'context of discovery where scientists formulate hypotheses. The next step in the scientific inquiry is deduction.

For Peirce, deduction is the second step in the scientific method. As mentioned above, deduction merely 'explicates what is in the premises.' But it plays a very important role in scientific inquiry. Its role in scientific inquiry is that of deducing consequences from a hypothesis that explains a surprising experience. As Peirce put it, "…the first thing that will be done, as soon as a hypothesis [i.e., abduction, TA] has been adopted, will be to trace out its necessary and probable experiential consequences. This step is *deduction*" (Peirce, 1998, p. 95). So deductive inference provides experiential consequences so that scientists are able to test hypotheses. In this way, scientists will be able to test hypotheses, or conjectures, through induction, a process I will explain in the following pages. "If the hypothesis passes the test of experience, then it is accepted—it is stable and believed until upset by a new surprising experience" (Misak, 2013, p. 48). This brings us to the role of induction in the scientific method.

As for induction, Peirce thinks that there are three kinds of induction: crude, qualitative and quantitative induction. For him, crude one is the weakest kind of induction "which goes on the presumption that future experience as to the matter in hand will not be utterly at variance with past experience. Example: "No instance of a genuine power of clairvoyance has ever been established: So I presume there is no such thing." (*A Neglected Argument for the Reality of God*). He claims that we do not generally make

these kinds of simple inferences. “In the special case of “qualitative induction” what is projected are the features (or qualities) implied by the theory: “… [T]his is equivalent to Peirce’s older concept of “hypothesis” and to what is commonly taken as IBE [Inference to the best explanation] …” (Minnameier, 2004, p. 82). Quantitative induction is the strongest kind of induction. Quantitative induction copes with statistical ratios. For example:

Case: these pencils have been randomly taken from this bag

Result: 1/3 of these pencils are brown

Rule: Therefore 2/3 of the pencils in the bag are brown

Quantitative induction can be seen as a kind of experiment. We ask what the probability is that a member of the experimental class of the “pencil” [added, T.A.] will have the character “brown” [added, T.A.] (Misak, 1991, p. 93). This kind of induction is the most important one for Peirce. In the rest of this work, unless otherwise stated, whenever I mention ‘induction’, I will mean “quantitative induction”.

Peirce writes, “induction is where we generalize from a number of cases of which something is true, and infer that the same thing is true of a whole class” (Peirce, 2014, p. 170). Even though he did not deal directly with the problems of induction that Hume mentioned, Peirce’s justification of inductive inferences is that induction is a self-correcting process. Haack writes,

> Peirce thinks of inductive arguments as, roughly, those which extrapolate probabilities from given data. His view of probability is frequentist; the probability of B given A is given in terms of the proportion of A's which are B's, and, when the A series is infinite, the probability is the limiting frequency, if any (Haack, 1976, p. 245).

In the scientific method, scientists test their hypotheses by induction. As a logician, Peirce is well that inductive reasoning does not guarantee that our theories are true *even* if they have passed the test. On Peirce's view, inductive reasoning is significant in the scientific method in that it is self-correcting. "The justification of it is that, although the conclusion at any stage of the investigation may be more or less erroneous, yet the further application of the same method must correct the error" (Peirce, 1934, p. 145). For instance, scientists test their hypotheses by the inductive inference, and if they pass, they are "…added to our body of belief" (Misak, 1991, p. 94). However, if scientists find new facts that are not compatible with the previous inductive inference, they need to reformulate their hypotheses in the light of those new facts. To Peirce, this characteristic of the inductive inference is the justification of its use.

To put it more explicitly, for Peirce, in the scientific method, the first step is an abductive inference.[12] Abduction can provide us with an explanation for some surprising experience. For instance, "fossils are found; say, remains like those of fishes, but far in the interior of the country. To explain the phenomenon, we suppose the sea once washed over this land" (Peirce, 1932, p. 625). This is what Peirce calls an abductive inference. We should remember, though, that its conclusion is a hypothesis. Then, we can deduce some experimental consequences from this abductive reasoning and test them by induction. Finally, as Misak puts it, "If the hypothesis passes the test of experience [i.e., in induction; TA], then it is accepted—it is stable and believed until upset by a new surprising experience" (Misak, 2013, p. 48). In other words, on Peirce's view, the

[12] It is important to notice that Peirce's account of science is different from 'the Hypothetic-Deductive model of science since the latter is not able to explain a logic of discovery. Besides this difference, as Haack points out, Peirce's account mainly resembles the Hypothetic-Deductive model in some respects.

scientific method combines the three basic forms of logical inference as follows abduction, deduction and induction, which is a dynamical method for the acquisition of scientific knowledge. As Minnameier put it, “Figure 1 illustrates the basic cycle underlying all these processes, where “t_0” indicates the original cycle (with t_0 being the initial problematic situation and $t`_0$, $t``_0$, ...being the test cases). “$t_{1,\ 2,}$ ...” refers to future situations to which the inductive generalization extends and in which, once they actually arise, the theory would have to be applied.” (Minnameier, 2004, p. 80).

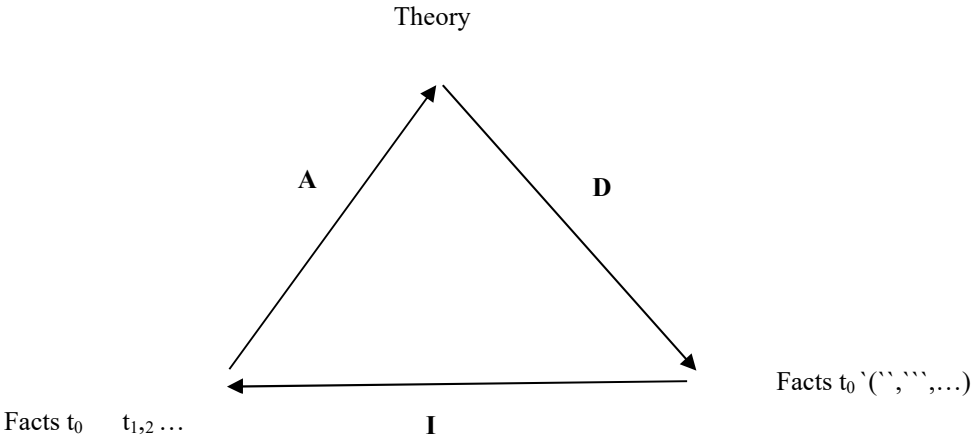

Figure 1. The Dynamical Interaction of Abduction, Deduction, and Induction (Minnameier, 2004, p. 81).

As already mentioned, Peirce does not insist that the available scientific methods in question are *the only methods* of scientific inquiries; they can change. Each field of science needs to develop its own method. But the task of scientific inquiry, which examines facts and discovers scientific laws which are real, is unchangeable, which is not an easy task to accomplish. However, Peirce has a strong belief that what all inquirers have reached at the end of the inquiry is the truth. He states this in one of his most quoted

and controversial sentences; “The opinion which is fated to be ultimately agreed by all who investigate is what we mean by the truth, and the object represented by this opinion is the real” (Peirce, 2014, p. 98). As this quotation implies, to Peirce, the real and epistemic (what truth is) are two sides of the same coin.

When we link his pragmatist theory of truth with his fallibilism, which entails that “we can never be absolutely certain about anything” (de Waal, 2014, p. 61), it will make sense why he made some modifications to this claim in later years. As Haack writes, Peirce changed his “…thesis that the truth is what the Scientific Community will in the long run agree on, and [he accepted, T.A] the thesis that the truth is what the Scientific Community would in the long run agree upon, if it did agree” (Haack, 1976, p. 244). On Peirce’s view, the scientific community plays a very crucial role in scientific inquiry. Peirce does not mean a small or large group of researchers who are investigating. It has nothing to do with the size of the scientific community. So, the role of scientific community needs to be interpreted.

The proposition “the thesis that the truth is what the Scientific Community would in the long run agree upon” makes truth seemingly relative. However, as mentioned, a belief in science must be public, impersonal as well as resulting from “interaction with something external to anyone’s mind” (Lane, 2007, p. 19). Taking all of this into account, “the thesis that the truth is what the Scientific Community would in the long run agree upon” cannot imply a relative account of science. As mentioned above, when I discussed the four methods of fixing a belief, the method of tenacity seeks to fix belief at the individual level. However, as Peirce point out, if people do not make themselves hermits, they will certainly affect each other's opinions. Thus, the problem becomes how to fix

belief, not at the individual level, but at the community level (Peirce, 2014, p. 98). This is the main reason why Peirce thinks that "the truth is what the Scientific Community would in the long run agree upon".

The previous two paragraphs can be concisely summarized as follows: A true belief/opinion has two aspects in the scientific method, namely a representationalist aspect and an investigative aspect. According to the representationalist aspect, "…a true belief…represents the real world" (Lane, 2007, p. 13), and to the investigative aspect, "a true belief…would be permanently settled in the minds of those who use the method of science" (Lane, 2007, p. 13). To Peirce, the scientific method is the best way to successfully establish both aspects of a true belief.

It seems that Peirce's account of scientific inquiry is largely compatible with the ideas of several twentieth century philosophers[13] of science. For instance, both Peirce and Popper believe our scientific theories are fallible. Peirce's idea of fallibilism is important because, as de Waal points out, pragmatists give us a new option (that is, fallibilism) to abandon both dogmatism and skepticism. In other words, pragmatists "…maintain that though we can be sure that many of our ideas are true, we cannot be absolutely certain of any single one of them" (de Waal, 2005a, p. 177). According to Peirce's fallibilism, we can have some true theories in science, but we are not in a position to claim that we can be "absolutely certain of any single one of them". He does not think there is any belief that is infallible. This is true of common sense as well. Here we need to say something regarding common sense to understand why he thinks that even commonsense knowledge is fallible.

[13] Namely, the Popper's, Kuhn's, Lakatos' and Laudan's.

First, Peirce does not think common sense attains infallibility. Like scientific theories, it is fallible. As he puts it, “[c]ommon sense improves; it does not, then, attain infallibility. Then, its decisions are subject to review.” (Peirce, 1935, p. 574) However, since common sense has a significant role in our daily life, it is not easy to doubt about its conclusions. Second, unlike Paul M. Churchland, who claims that common sense is imperfect science, Peirce would not claim that “common sense is nothing but an imperfect kind of science…” (Peirce, 1958, p. 202), but Peirce definitely thinks that scientific inquiry can correct the conclusions of common sense. As Peirce wrote, “The history of the science of dynamics is that of gradual correction by inference from familiar experience…of primitive conceptions of "force" and "matter" (Peirce, 1935, p. 573). Since these conceptions are gradually corrected, we need to make a choice between these primitive conceptions and scientific conceptions if there is a conflict between them. If we have a chance to criticize common-sense beliefs, we should do (de Waal, 2005a, p. 98).

Peirce and Kuhn place a great importance on the role of scientific community in their philosophy of science. In addition, Peirce thinks that any inquiry, especially a scientific one, begins with a genuine doubt. When Laudan claims “science is essentially a problem-solving activity”, I do not think he meant that there are problems ‘out there’ and all scientists have to do is to solve them. What he indeed means is that both practical and theoretical problems are essentially problems for us. Therefore, as long as we have a doubt about anything, there are problems we need to solve. I think Peirce would agree with this claim of Laudan’s.

In the present chapter, I dealt with the main aspects of Peirce’s account of truth based on his article “The Fixation of Belief” and his account of reality based on his

article entitled “How to Make Our Ideas Clear” and with basic idealism. In the next chapter, I will develop a Peircean account regarding the unobservable entities in science.

CHAPTER 4: A PEIRCEAN SCIENTIFIC REALISM

In the present chapter, I aim to develop a Peircean account regarding the unobservable entities in science. I think that the Peircean account is based on his views on truth, reality, and basic idealism. The current debate on unobservable entities in science runs between empiricists, such as Bas van Fraassen, and realists, such as Paul Churchland. As I said in the first chapter, looking at the names given to both sides of the discussion, one may get confused. While the phrase "scientific realism" implies the name of an ontological school, van Fraassen's "constructive empiricism" suggests the name of an epistemological school. In the history of philosophy, realist is contrasted with anti-realist, though empiricist is contrasted with rationalist. In the philosophy of science, the debate between these positions was overcome by idealism. Similarly, I think the current debate on unobservables can be overcome by an idealist approach. In the following pages, I will outline this story in order to make clear my position. Then I will answer the question whether Peirce would accept the idea that unobservable entities our scientific theories postulate exist. Finally, I will propose a Peircean account that answers this question in favor of scientific realism. Of course, the resemblance is in terms of consequences not in terms of philosophical views. As a matter of fact, as we will see, the Peircean answer is based on idealism, to be more precise, his basic idealism.

In the history of philosophy, according to Peirce, one of the most important debates is the debate regarding nominalism and realism, also known as the problem of universals. Roughly speaking, nominalists deny the existence of universals. They think that there are just particulars. On the other hand, realists believe in the existence of both universals and particulars. Realists explain the resemblance found among particulars in

terms of universals. For instance, each particular bird has feathers, a toothless beaked jaw, and wings. Realists think that all these properties exist independently of humans. We just name them. However, nominalists think universals are purely of our own making, or constructions of language. In modern philosophy this problem of universals has transformed into a new problem; the problem whether innate ideas exist. Innate ideas are inborn. In other words, we do not get them from experience. Rationalists such as Descartes believed in the existence of innate ideas while empiricists like Locke denied the existence of innate ideas. Empiricists like Locke claimed that an infant's mind is like a tabula rasa—a blank slate. On Locke's view, we obtain all knowledge through experience. It is important to remark that in medieval philosophy, the debate concerning the existence of universals was an ontological or metaphysical problem. However, in the modern philosophy, more precisely after Descartes, as their names (rationalism and empiricism) indicate, the debate became mainly epistemological, although most empiricists are also nominalists. According to Peirce, "British philosophers…have shown strong nominalistic tendencies since the time of Edward I, or even earlier. Berkeley is an admirable illustration of this…" (Peirce, 1958, p. 10). What is more, most rationalists like Descartes were realists. This is the main picture of the philosophical panorama of pre-Kantian philosophy.

Kant offered a totally new perspective. He claimed that the debate between rationalists and empiricists took us nowhere. His philosophy is a synthesis of rationalism and empiricism in some sense. He came up with a new philosophical view, which is similar to what Copernicus did in astronomy. As Kant put it,

> Up to now it has been assumed that all our cognition must conform to the objects; but all attempts to find out something about them a priori through concepts that

> would extend our cognition have, on this presupposition, come to nothing. Hence let us once try whether we do not get farther with the problems of metaphysics by assuming that the objects must conform to our cognition, which would agree better with the requested possibility of an a priori cognition of them, which is to establish something about objects before they are given to us (Kant, 1998, p. 110).

As the quotation indicates, Kant's Copernican revolution is that while we passively receive data through our senses, our mind (human mind) actively processes these sense data according to its own a priori rules. "So the sensible world and its phenomena are not entirely independent of the human mind, which contributes to its basic structure" (Rolf, 2019). This means that Kant is an idealist in some sense. For him, empirically real objects depend on human minds. Kant's most controversial thesis is that all we can know is appearances (phenomena). We cannot know things in themselves (noumena). This is mainly what Kant's transcendental idealism comes down to.

As Kant claimed both rationalists (realists) and empiricists (nominalists) become in some sense the one and same side, compared with Kant's idealism (Kant, 1998, p. 99). Because of this, Kant's Copernican revolution changed the game. To use an analogy, rationalism's opposition to empiricism is a colonial war, while "…there is *civil* war, between say Locke and Berkeley" (Hacking, 2010, p. 95), as both are empiricists, and "[f]inally there is *total* war, chiefly a product of more recent times. Maybe Kant began it." (Hacking, 2010, p. 96). This analogy implies that if it is to be a discussion between rationalists and empiricists, there must be some assumptions that both sides accept. Otherwise, there could not be any debate between them. This is why each side tried to colonize the entire territory of knowledge. At the same time, there is a debate among empiricists as well. This is a civil war because it is among brothers. Finally, there is a total war. This war usually starts when someone thinks that the current debate takes us

nowhere. In this case, Kant thought both sides of the debate (rationalists and empiricists) were based on wrong assumptions.

We can use this analogy to clarify the different sides in the current debate. For instance, the war between scientific realism and antirealism is a colonial one. On the other hand, there is a civil war between, say, Stathis Psillos and Paul M. Churchland, and there is a total war which was started by Hilary Putnam and Ian Hacking. Hilary Putnam was a scientific realist but later became antirealist. Since he rejects the assumptions of other antirealists, like van Fraassen, he also changes the war. As for Hacking, he rejects the assumption of scientific realism which claims that our best scientific theories represent a true picture of the real world. Likewise, in this thesis, I propose a Peircean account—one that would start a total war as well. Although the Peircean account is seemingly compatible with the results of current scientific realists. it rejects some philosophical assumptions of scientific realism. How does the Peircean account change the war?

When one takes an introductory course about ontology in a philosophy department, he or she will be told that the opposite of realism is idealism. However, in the current debate regarding the status of unobservable entities, while we call one side 'scientific realism', we call the other side constructive *empiricism* or antirealism. But we know from epistemology that the opposite of empiricism is rationalism. What is more, both constructive empiricists and scientific realists are realists in a sense. Both accept that there is a mind-independent world and that we can obtain knowledge of this world. As van Fraassen wrote, "…scientific realists have appropriated a most persuasive name for themselves (aren't we all scientific, and realists, nowadays) …" (van Fraassen 1980, p.

5). As I pointed out in the first chapter, scientific antirealists deny default positions when it comes to believing in the existence of unobservable entities—their dispute is about the status of unobservable entities postulated by scientific theories. Another contemporary philosopher, Howard Sankey, claims that "…scientific realism [should, T.A] be understood as a form of realism in general" (Sankey 2008, 3). As van Fraassen indicates in the quotation, scientific antirealists also see themselves as realists. This is why we should see this war between scientific realists and antirealists as a civil war. However, as already mentioned, the Peircean view (regarding the status of unobservable entities in scientific inquiry) proposed here is (basic) idealism.

Before embarking on what the Peircean account of realism/idealism is, we need to answer the question whether Peirce accepts the existence of the unobservable entities that our scientific theories postulate. Of course, accepting the existence of certain unobservable entities is not enough to make someone a scientific realist. He/she must also accept that we have good epistemic reason to suppose that there are unobservables.

Can Peirce even be relevant to the contemporary debates on scientific realism/antirealism? Or is there any evidence that allows us to construe Peirce as a scientific realist/antirealist in the sense of the contemporary debate? My answer to both questions is affirmative. We may find the answer to both questions in Peirce's discussion of the hardness of a diamond. As Peirce wrote in a 1905 manuscript, "…[the] condition of the diamond's atoms to which its adamantine hardness is due to, perhaps the polymerization of the molecules. At any rate the hardness can be nothing but one of the manifestations of some condition of the diamond's atoms" (Peirce, 2014, p. 103-4). It can be clearly seen from the citation that Peirce explains the hardness of the diamond in terms

of its unobservable entities such as its molecular structure and its atoms. Another example can be given to show that Peirce is a scientific realist in the contemporary sense. Peirce contends that physicists should not "confine themselves to such a "strictly positivistic point of view." Students of heat are not deterred by the impossibility of directly observing molecules from considering and accepting the kinetical theory; students of light do not brand speculations on the luminiferous ether as metaphysical; and the substantiality of matter itself is called in question in the vortex theory, which is nevertheless considered as perfectly germane to physics. All these are "attempts to explain phenomenally given elements as products of deeper-lying entities" (Peirce, 2010, p. 233). I think these two citations from Peirce's works might be enough to prove that Peirce is a scientific realist regarding the existence of unobservable entities scientific theories postulate. Still, I want to give another evidence that suggests Peirce accepts the existence of unobservable entities.

On Peirce's view, *all* the conclusions of science are such that they cannot be directly observed. What can directly be observed is science's premises. He even goes as far as to say that "The things that any science discovers are beyond the reach of direct observation" (Peirce, 1935, p. 1). To illustrate this, he gave plenty of examples from scientific theories at that time. For instance, he thinks that we cannot see …energy, nor the attraction of gravitation, nor the flying molecules of gases… nor the forests of the carbonaceous era, nor the explosions in nerve-cells. It is only the premisses of science, not its conclusions, which are directly observed (Peirce, 1935, p. 1).

This quotation should be enough for us to be convinced that Peirce accepts that science goes beyond what we directly observe. However, de Regt goes a step further and

claims that "Peirce was obviously of the opinion that scientists *do have good (epistemic) reason* [emphasis added] to suppose that there *are* unobservables like molecules to account for the hardness of the diamond by postulating the "high polymerization of the molecule"" (de Regt, 1999, p. 385). But what is Peirce's good epistemic reason(s) to suppose that unobservable entities that scientific theories postulate exist?

The answer to this question, in my opinion, lies mainly in Peirce's understanding of the roles of abductive and inductive inferences in scientific inquiry. As Misak puts it,

> The addition of abduction to the standard two types of inference (deduction and induction) does a great deal of work in Peirce's system. For one thing, it allows us to infer (some sorts of) metaphysical hypotheses, hypotheses about the past, and hypotheses about *unobservable entities* (Misak, 1991, p. 96, emphasis added).

For Peirce, by abductive inference we usually infer the existence of unobservable entities in scientific inquiry. But this is the case in history as well. As already mentioned in the previous chapter, since the objects of the past generally do not exist now, the statement, "Napoleon Bonaparte once existed', is a product of abductive inference. In science, one of the best explanations of "…an observed curved path in Wilson's cloud chamber is the existence of an electron" (Niiniluoto, 2018, p. 152). Of course, Peirce notes, these kinds of inferences are fallible. But they may still be true or truthlike. The main point here, according to Misak, is that Peirce claims that "it is only the premises, not the conclusions, of science which must be directly observable… The data will be observable data, but the explanations of the data need not be empirical hypotheses" (Misak, 1991, p. 96). Therefore, our hypotheses[14] must be capable of "being tested by induction". This brings us to the testing process of Peirce's account of philosophy of

[14] Other important criteria for a preferable hypothesis Peirce sets are that the hypothesis must explain the surprising observations we made. Some empirical consequences must be driven from the hypothesis. The chosen hypothesis must be "economical in time, thought, money and energy" (Misak C. , 1991, p. 99).

science, namely the role of induction in scientific inquiry. Since the role of induction in scientific inquiry has been dealt with in the previous chapter, I will not address this in detail here.

As seen above, Peirce agrees with scientific realists in that unobservable entities such as atoms are proper objects of science. However, as will be seen below, the Peircean account of scientific realism is essentially different from contemporary scientific realism. As Hacking points out, "[s]cientific realism is commonly discussed under the heading of representation" (Hacking, 2010, p. 146). In other words, scientific realists often argue that our best scientific theories represent the world outside us correctly, and as a result, they defend a kind of correspondence theory of truth. They claim that there is a world there and some of our scientific theories are true representations of this world. In brief, this is what their understanding of reality and truth are. It seems that the debate is mainly about these two concepts. For instance, Hacking claims that "… there are two quite distinct … origins of the idea of 'reality'. One is the reality of representation, the other, the idea of what affects us and what we can affect" (Hacking, 2010, p. 146). As we saw it, the former is what scientific realists defend. Hacking himself supports the latter. However, I think Peirce has another option, which is consistent with both views. In fact, Peirce's view consists of both views. On Peirce view, we do not have to make a choice between these options. As mentioned in the previous chapter, Peirce's account of truth has dual aspect; the representationalist aspect and investigative aspect. To repeat the quotation, "The opinion which is fated to be ultimately agreed to by all who investigate, is what we mean by the truth, and the object represented in this opinion is the real" (Peirce, 2014, p. 98). As mentioned in the previous chapter, the quotation implies a kind

of idealism. It entails that "If something is real, then it can be represented in a mental state; it can be thought about, understood, cognized" (Lane, 2007, p. 59). This is Peirce's basic idealism. According to his basic idealism, whatever is real can be the object of cognition.

As implied above, Peirce's basic idealism "is very different from Kant's transcendental idealism, which denies that our thoughts can represent reality as it is in itself, … and from Berkeley's ontological idealism, which denies that there are real external things" (Lane, 2007, p. 70). As well known, in Kant's philosophy, there are two kinds of unknowable, Things-in-themselves (*Dinge an sich*) and immortality, freedom and God. Peirce's basic idealism rejects Things-in-themselves totally. On Peirce view, "ghost-like hypotheses about things-in-themselves" can be fabricated by anyone. However, they are unrefutable. As for the latter, either "indefinite research" would eventually settle questions about them, in which case those things are knowable, or it would not, in which case questions about them are meaningless" (Lane, 2007, p. 64).

Peirce's basic idealism is also different form Berkeley's ontological idealism, claiming that there are no real external things which are not thought. As shown in the previous chapter, for Peirce, the method of science is based on the hypothesis that there are real things. Peirce tries to answer how we come to know that there are any realities. Peirce gives four observable outcomes of using the scientific method which imply that there are realities.

Why do we have to be a (basic) idealist in order to solve the epistemic problem—the problem of how we can know the truth and how we are able to say there are

unobservable entities? To answer this question, we need to look at Hume's problem, widely known as Hume's fork.

David Hume, in his famous book called *An Enquiry concerning Human Understanding*, says,

> When we run over libraries, persuaded of these principles, what havoc must we make? If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, "*Does it contain any abstract reasoning concerning quantity or number?* No. *Does it contain any experimental reasoning concerning matter of fact and existence?* No. Commit it then to the flames: For it can contain nothing but sophistry and illusion (Hume, 1999, p. 211).

Hume's sentences come at end of the epistemic debate between rationalists and empiricists in 18th century. There were two options at that time. If we were an empiricist and had a coherence view, we would accept that there is not any ground for the knowledge, so we couldn't justify our knowledge. If were a rationalist, we would use some metaphysical principles[15]. As we know, each metaphysical view had some problems, so many philosophers eliminated the metaphysical views and the term "metaphysics" for two centuries. For instance, Kant's solution of the problem is transcendental idealism. Kant wanted to get to rid of metaphysical commitments and to ground scientific knowledge, particularly Newton's physics. But German idealism took the idealism back to metaphysics. In Anglo-Saxon world specially in Britain, idealism was perceived as Hegelian or Berkeleyan metaphysics. So, most philosophers returned to the realist view (Collingwood, 1939, p. 15-21). However, Hume's problem has remained unsolved. Some philosophers like Popper, thought that the problem is the only epistemological; therefore, they presented epistemological solutions like falsification. But

[15] Here, the term "metaphysics" is used as what Alexander Baumgarten means in his famous book, *Metaphysics*. For instance, "METAPHYSICS is the science of the first principles in human knowledge" (Baumgarten, 2013, p. 99). Kant also used this book in his metaphysics classes.

an important part of the problem is ontological i.e., this problem is not only about induction but also the order of universe (Meillassoux, 2015, p. 6). Hume's problem claims that two basic beliefs of scientific knowledge which are that there is an order in the universe, and we know the order are not grounded in realistic view. If we are to ground scientific knowledge and the situation of the unobservable entities, we must solve Hume's fork. We have two options to solve the problem. If we remain a realist like the scientific realists and antirealists, we will find an answer to the problem in realistic view. If we become an idealist, we will use the solution of the idealist view like Peirce's solution. Nowadays, the realist view overlooks Hume's problem. Therefore, we should choose the idealist view to overcome the problem. As mentioned above, metaphysical view has had some problems. So, we need an idealist view which does not have metaphysical commitments. I think Peirce's basic idealism does satisfy this condition.

Before finishing this chapter, I want to say a few words on what it looks like to have a true scientific theory at the end of inquiry that is in accordance with a Peircean account of science. For this, I refer to the contemporary American philosopher John Searle, more specifically his *Mind, Language and Society*. In this book, Searle claims that there are some scientific theories which are about how the world works and they are not a matter of choice. These theories are the evolutionary theory of biology and the atomic theory of matter. In the end they may turn out to be false, but "given the overwhelming amount of evidence for them, they are not seriously disputed among educated members of our civilization" (Searle, 1999, p. 40). It seems that such theories can be thought to be true according to Peirce's account of scientific method since we cannot only think but also imagine an alternative theory of evolutionary theory and atomic theory. One may

object this claim by saying there is an alternative theory of evolutionary one, namely, the theory of creation. However, I think it is not a scientific theory. It is a “unscientific one”.

CONCLUSION

In the philosophy of science, there is a controversial issue regarding the status of unobservable entities postulated by our current scientific theories. While scientific realists accept that some of our successful current scientific theories are (approximately) true and unobservable entities these scientific theories postulate exist, scientific antirealists simply reject these claims. As both sides of the debate indicate, the debate regarding unobservable entities is essentially epistemological. More precisely, the debate is about the limits of scientific knowledge. So, in my opinion, this issue cannot be settled without understanding the nature of scientific theories. Accordingly, what the nature of scientific theories is and whether unobservable entities scientific theories postulate exist were the main concerns of this thesis.

The first chapter was mainly about the central arguments on both sides and the context of the debate, and I explained why I brought Peirce's understanding of truth and reality and idealism into this debate. Scientific realism has mainly two tenets. One of them is that science seeks truth and the other one is that some of our current scientific theories are (approximately) true. In order to defend these two tenets, scientific realists commit to three philosophical views, namely, the existence of a mind-independent world of observable and unobservable entities, a correspondence theory of truth, and the epistemological view that we can know that some of our theories are (approximately) true. On the other hand, scientific antirealists reject at least one of these three commitments, and they reject both of the tenets of scientific realists.

The second chapter was concerned with the nature of scientific theories. As shown in this chapter, many well-known philosophers of science, such as Kuhn, Lakatos

and Laudan, come to believe that we do not have good (epistemic) reasons for believing that our current scientific theories are (approximately) true. As a result, as long as we understand 'truth' as a correspondence theory, we cannot defend the idea that some of our current scientific theories are true. Therefore, it is epistemically not plausible to believe in the existence of the unobservable entities that scientific theories postulate. This is the conclusion of the second chapter.

In the third chapter, I attempted to show that Peirce's account of truth, reality and scientific method. Peirce's understanding of the truth of scientific theories, I claimed, are an 'optimistic meta-induction' in his pragmatic sense. Peirce thinks there are four ways of fixing beliefs, but the method of science, with its abduction-deduction-induction pattern, is the only one which can ideally provide 'permanently settled opinions' for us. The conclusion of this chapter is that: since the method of science is a self-correcting process, it is plausible to claim that the scientific method can ideally provide truth in the long run. This may cause us to give up believing the claim of scientific realists that our successful current theories must be true. However, Peirce's account of the scientific method enables us to still maintain the claim that science must seek truth, which is the axiological tenet of the scientific realists. The implications of Peirce's account on the other tenet of the scientific realists which says that our current scientific theories are (approximately) true were dealt with in the fourth chapter.

The fourth chapter was concerned with some implications of a Peircean account of the scientific method regarding the existence of unobservable entities that scientific theories postulate, what the epistemic reasons of a Peircean account of scientific method are, and why we need an idealist view in this debate. I did this based on Peirce's

understanding of the self-correcting nature of scientific inquiry and his basic idealism. The main argument of that chapter was that the debate regarding scientific realism should be idealist because the other option (the realist one) must solve Hume's problem which is claimed to remain unsolved. Hume's problem argues that two basic beliefs of scientific knowledge, one of which is that there is an order in the universe, and the other one which is that we know the order, are not grounded in realistic view. Before finishing the chapter, I gave two examples of scientific theories that are accepted not only by all the members of the scientific community but also by educated members of our civilization. In the light of these, it is plausible to defend the claim that we have good epistemic reasons to believe the existence of unobservable entities in science according to Peircean account of scientific method.

In this thesis, I proposed a Peircean account of philosophy of science in order to defend two tenets of scientific realism mentioned above. I claimed that the Peircean account allows us to keep both tenets. In other words, the Peircean account accepts the conclusion of scientific realists (that unobservable entities exist, or are external to the mind), but rejects some of their arguments, like the no-miracle argument and some of their philosophical commitments such as a realist view. Peirce's understanding of what reality and truth and his basic idealism are, which we obtain by applying his pragmatic maxim to these concepts, gives us a new perspective to understand the status of unobservable entities in science.

The thesis was written in the paradigm/spirit of pragmatism (pragmaticism). In a sense, this implies that the pragmatic method should be able to solve our current philosophical problems. This is also what I tried to do in this thesis. Both tenets of

scientific realists (i.e., science seeks truth, and our current successful theories are (approximately) true) become plausible from Peircean account. The implications of my proposal of the Peircean account demands further research. This master's thesis is expected to serve as a humble step in this direction and towards an understanding of the nature of scientific theories and unobservable entities from the Peircean point of view.

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CURRICULUM VITAE

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Education

- PhD in Philosophy, Maltepe University, İstanbul, Turkey, Expected Graduation:
- MA in Philosophy, IUPUI, Indiana, USA, January 2022
- BA in Philosophy, Kocaeli University, Kocaeli, Turkey, 2009-2013

Honors, Awards, Fellowship Research and Training Experience

- Turkey's Ministry of National Education Fellow, 2014
- Istanbul 29 May University Fellow, 2013
- Erasmus Exchange Programme, 2011, St. Clement of Ohrid University of Sofia, Sofia, Bulgaria

Professional Experience

- Giving Private English Language Lessons for YDS, 2013-2019
- Okurkitaplığı Publising Company, 2012-2013, İstanbul, Turkey
- İslamoğlu Publishing Company, 2002-2003, İstanbul, Turkey

Certificates

- TEFL, 2020
- Intensive English Program, 2015-2016, University of Georgia, Georgia, USA
- V. Logic Workshop, 2015, Uludağ Philosophy Association (Certificate of Appreciation), Bursa, Turkey
- Logic Summer School, 2014, Logic Application and Research Association Feza Gürsoy Fizik ve Matematik Uygulama ve Araştırma Merkezi, Bosphorus University, İstanbul, Turkey

- Elementary Psychology (online education), 2013, Psychologists and Psychiatrists Association

Publications

- Rationality in Lakatos' Philosophy of Science, Sakarya University Basımevi Müdürlüğü, Sakarya, 2014
- The Book of II. Turkuey's Postgraduate Studies Congress, Bursa Büyükşehir Belediyesi Kitaplığı, 2013 (as a member of editorial board)
- Translation of "Progress and Its Problems" by Larry Laudan, University of California Press, 1978, (with Zafer Güncüm), (in progress)
- Translation of "Philosophy in the Classroom" by Matthew Lipman (in progress)

Presentations

- Rationality in Lakatos' Philosophy of Science, III. Turkey's Postgraduate Studies Congress, Sakarya University, Sakarya, 2014
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Language

- English (fluent)
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Association Membership

- Phi Sigma Tau, Member and Treasurer/Secretary, 2017-present