The Appearance and the Reality of a Scientific Theory

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Abstract
Scientific realists claim that the best of successful rival theories is (approximately) true. Relative realists object that we cannot make the absolute judgment that a theory is successful, and that we can only make the relative judgment that it is more successful than its competitor. I argue that this objection is undermined by the cases in which empirical equivalents are successful. Relative realists invoke the argument from a bad lot to undermine scientific realism and to support relative realism. In response, I construct *the argument from double spaces*. It is similar to the argument from a bad lot, but threatens many philosophical inferences, including relative realists' inference from comparative success to comparative truth.

Keywords
Appearance and Reality, Argument from a Bad Lot, Argument from Double Spaces, Relative Realism, Scientific Realism, Success

1. Introduction

Moti Mizrahi is a rising star in the scientific realism debate. Not surprisingly, he (2020) defends an original position that he calls "relative realism." It holds that our best theories are closer to the truth than their alternatives. He takes this position to lie in the middle between scientific realism and antirealism. Since it is less committed to the claims of science than scientific realism is, it avoids some of the criticisms leveled at scientific realism. This article critically examines relative realism from the perspective of scientific realism.

The outline of this article is as follows. In Section 2, I provide an example of a scientific claim to clarify what is involved in subscribing to relative realism. In Section 3, I clarify what it means say that a theory, T, is successful, and then argue that saying that T is successful implies that it *appears* to be true and empirically adequate. In Section 4, I argue that scientific realists are right to distinguish, while relative realists are wrong not to distinguish, between the best of unsuccessful rival theories and the best of successful rival theories. In Section 5, I critically respond to Mizrahi's claim that Bas van Fraassen's (1989) argument from a bad lot undermines scientific realism, but not relative realism. I construct an argument that I call "the argument from double spaces," which is similar to the argument from a bad lot, but which undermines relative realism and other philosophical positions.

2. Relative Realism

Relative realism holds that "we have good reasons to believe that, from a set of competing scientific theories, the more empirically successful theory is *comparatively true*, that is, closer to the truth relative to its competitors in the set" (Mizrahi 2020, 115). The concept of comparative truth is distinct from that of approximate truth. To say that T is approximately true means that it is *close* to the truth. Suppose that two competing theories are completely false,

i.e., they are far from the truth and thus not approximately true. Yet, one of them might be comparatively true (Mizrahi 2020, 114).

What is involved in subscribing to relative realism? Relative realists do not believe what T says about the world. They only believe that what T says about the world is closer to the truth than what its competitor says about the world. For example, evolutionary theory says that natural selection is the "process allowing the proliferation of organisms that are relatively better adapted to external environmental conditions" (Ansdell and Hanson 2016, 179). Relative realists do not believe what Ansdell and Hanson say about natural selection. They only believe that what Ansdell and Hanson say is closer to the truth than what an alternative to evolutionary theory says. Relative realists also admit that what Ansdell and Hanson say might be utterly false. Even if it is utterly false, it is still comparatively true, as long as what they say is closer to the truth than what the alternative says. By contrast, scientific realists believe what Ansdell and Hanson say about natural selection.

3. Success

Before evaluating relative realism, we need to be clear about the concept of success. Laudan states that "a theory is successful if it makes substantially correct predictions, if it leads to efficacious interventions in natural order, if it passes a battery of standard tests" (Laudan 1981, 23). This definition clarifies what it means to say that T is successful. As far as I know, no other philosopher has made the notion of success clearer than Laudan.

Let me further clarify the notion of success. To say that T is successful entails that "*some* of its observational consequences *turned* out to be true" (Park 2016, 604). Consequently, to attribute success to T is to make the *epistemic* claim that we know that some of what T says about observables are true. Consequently, if T is successful, we know that it is successful. It is implausible to say that T is successful, but that we do not know that it is successful. In other words, it is implausible to say that T has passed empirical tests, but that we do not know that it did.

By contrast, to attribute empirical adequacy to T is to make the *semantic* claim that all of what it says about observables are true, but not the epistemic claim that we know that all of what it says about observables are true. Even if T were empirically adequate, we may not know that it is so, just as even if T were true, we may not know that it is so. Thus, it is conceptually sound to say that T is empirically adequate, but that we do not know that it is so, just as it is conceptually sound to say that T is true, but we do not know that it is so.

This fundamental difference between success and empirical adequacy implies the following differences between them. Only one condition needs to be met for T to be empirically adequate, viz., whatever it says about observables is true. By contrast, many conditions need to be met for T to be successful (Park 2016, 604–615). For example, scientists should have financial resources. There should be oxygen in their laboratories. Unless such conditions are met, T cannot be successful, even if it is empirically adequate and in scientists' hands. By contrast, T can be empirically adequate whether those conditions are met or not. An empirically adequate theory is empirically adequate whether or not scientists have the financial resources to ascertain its predictions.

The success of T is a means to know that T has certain semantic properties, such as truth and empirical adequacy. In this sense, success is to a semantic property what light is to a physical object. Just as light enables us to see a physical object, so success enables us to see a semantic property. This difference between success and a semantic property is particularly important in this article. Saying that T is successful implies that it *appears* to have a certain semantic property, whether that semantic property is truth or empirical adequacy. However, its appearance might be misleading, i.e., although successful, T might be false and empirically

inadequate. In short, its appearance might disagree with its reality. Keep in mind that it is legitimate to distinguish between the appearance and the reality of T.

4. Successful Rivals vs. Unsuccessful Rivals

Scientific realists and relative realists make different judgments and inferences regarding T. Scientific realists make the *absolute* judgment that T is successful as well as the relative judgment that T is comparatively successful, and then infer that T is true. By contrast, relative realists only make the relative judgment that T is comparatively successful, and then infer that T is comparatively true. Scientific realists' inference admittedly runs more epistemic risk than relative realists' inference.

However, I make the following defense of scientific realists' inference in relation to relative realists' inference. To use an analogy, suppose there are two NBA players: p_1 and p_2. We make the relative judgment that p_1 is taller than p_2. Still, we can make an absolute judgement that both are tall. Similarly, we make the relative judgement that T is closer to the truth than its alternative. Still, we can make the absolute judgment that they are approximately true. In short, we can make both relative and absolute judgments at the same time.

Suppose T is closer to the truth than its alternative, but both are unsuccessful. In such a case, scientific realists would agree with relative realists that we have good reason to believe that T is comparatively true, but not that it is approximately true. But what if both are successful? For example, the caloric and kinetic theories competed with each other, and were both successful. Scientific realists would say that we have good reason to believe that they are both approximately true. Comparing between successful rivals is like comparing between the NBA players. Just as either of the NBA players is tall, so any of successful rivals is approximately true. In short, scientific realists distinguish between the best of unsuccessful rivals and the best of successful rivals, claiming that we have good reason to believe the former is comparatively true, but not that it is approximately true, while we have good reason to believe that the latter is both (approximately) and comparatively true.

In contrast, relative realists do not distinguish between the best of unsuccessful rivals and the best of successful rivals. They claim that we have good reason to believe that both are comparatively true, but not that any of them is approximately true. On what grounds do they reject scientific realists' view that the best of successful rivals is (approximately) true? Relative realists claim that we cannot make the absolute judgement that T is successful, although we can make the relative judgment that it is more successful than its alternative. Therefore, we cannot say that the best of successful rivals is (approximately) true. Mizrahi states that we cannot make "*absolute* judgments about scientific theories, such as *T* is well-confirmed, *T* is predictively successful, *T* is approximately true (that is, close to the truth), or *T* is likely true" (Mizrahi 2020, 126).

Admittedly, we usually make the relative judgment that T is better confirmed than its competitor. It does not follow, however, that we cannot make the absolute judgment that both are highly confirmed. Many scientific realists and antirealists make the absolute judgment that past and current theories, such as the caloric and kinetic theories, are successful. Their absolute judgments mesh well with Laudan's definition of success, cited in Section 2 above. Recall that to say that T is successful is to make the epistemic claim that we know that some of what T says about observables are true. In accordance with this definition, we can make the absolute judgment that both the caloric and kinetic theories are successful.

Moreover, we cannot make a relative judgment, and can only make an absolute judgment about the success of T, when T competes with its empirical equivalents. Suppose Newton's mechanics is composed of the law of gravity, the three laws of motion, and the assertion that the universe does not move in relation to absolute space. It competes with infinitely many

alternatives, which share the four laws with Newton's mechanics, but which make different assertions about how fast the universe moves in relation to absolute space (van Fraassen 1980, 46). All of these rival theories are empirically *equivalent*. It follows that, if one of them is successful, they are all *equally* successful. Since none of them is more successful than another, we cannot make the relative judgment that any is comparatively successful, and we can only make the absolute judgment that they are successful.

This example of underdetermination weakens relative realism. Since none of the competitors is more successful than any other, relative realists cannot infer that any of them are comparatively true. By contrast, scientific realists can infer that they are all approximately true, provided that one of them is true, given that they share the four laws (Park 2014, 110). The best of the rivals is true, and even the worst of the rivals is approximately true. Again, comparing between successful rivals is like comparing between the NBA players. Even the smallest of the NBA players is tall.

5. The Argument from Double Spaces

Van Fraassen (1989) and Mizrahi (2020) would reject scientific realists' contention that the best of successful rival theories is (approximately) true. They defend a famous argument against scientific realism called "the argument from a bad lot." It holds that, even if T is the best of all the conceived competitors, we cannot conclude that it is true because there might be unconceived alternatives which are better than T, i.e., because T "may well be the best of a bad lot" (van Fraassen 1989, 143). Mizrahi (2020, 54 & 128) appeals to this argument to undermine scientific realism and to support relative realism.

How do scientific realists respond to the argument from a bad lot? Park (2017a, 30–31) observes that the premise of the argument is a possibility statement, but its conclusion is a normative statement, and notes that such an argument would be rejected by David Hume (1888/1978, 469) who points out that a normative statement cannot be derived from a factual statement. In addition, Park (2017b, 61–62) argues that the argument from a bad lot, if correct, has a disastrous implication for van Fraassen's positive views, such as his contextual theory (1980).

In this article, I do not pursue these criticisms against the argument from a bad lot. Instead, I grant that it is correct, and then construct a similar argument, which has disastrous implications for relative realism and other philosophical positions. I call the similar argument "the argument from double spaces." It is so named because it invokes two logical spaces of unconceived scientific theories, which I call "the T-space" and "the F-space." Let me explicate these notions one by one.

The T-space is inhabited by the unconceived scientific theories that are commonly fated to lead us to *true* beliefs about themselves. For this reason, the T-space is so named. Suppose scientists select a scientific theory from the T-space. They put it to empirical tests, and it succeeds. To say that it is successful means that it *appears* to be true. Since it is from the T-Space, its appearance agrees with its reality. Its reality is that it is true. Thus, to say that its appearance agrees with its reality implies that it is true. Suppose, now, that T is more successful than its competitor, which means that it appears to be comparatively true. Since it is from the T-space, its appearance agrees with its reality. Its reality is that it is comparatively true. Thus, to say that its appearance agrees with its reality implies that it is comparatively true.

By contrast, the F-space is inhabited by the unconceived scientific theories that are commonly fated to lead us to *false* beliefs about themselves. Suppose scientists select a scientific theory from the F-space. They put it to empirical tests, and it succeeds. To say that it is successful means that it appears to be true. Since it is from the F-space, however, its appearance disagrees with its reality. Its reality is that it is false. Thus, to say that its appearance

disagrees with its reality implies that it is false. Suppose, now, that it is more successful than its competitor, which means that it appears to be comparatively true. Since it is from the F-space, however, its appearance disagrees with its reality. Its reality is that it is farther from the truth than its alternative, i.e., it is comparatively false. Thus, to say that its appearance disagrees with its reality implies that it is comparatively false.

It is not just a figment of imagination that, even if T is more successful than its alternative, T might be farther from the truth than the alternative. Ptolemy compared his geocentric theory with the heliocentric theory (Frost-Arnold, 2019: 911). He chose the former over the latter, however, because it was more successful in light of the evidence he had. To take another example, caloric scientists considered the kinetic theory in the 19th century, but rejected it because the caloric theory was more successful than the kinetic theory in light of the evidence that they had. Several other such historical episodes can be found in Greg Frost-Arnold (2019, 911–913). These episodes open up the possibility that the appearance of T might not accord with its reality, which implies that, even if T is comparatively successful, it might be comparatively false.

The notions of the T-space and the F-space cast new light on how to understand T, a current theory. If T is successful and true, we can conclude that it was selected from the T-space. By contrast, if T is successful but false, we can conclude that it was selected from the F-space. In addition, if T is comparatively successful and comparatively true, we can conclude that it was selected from the T-space. By contrast, if T is comparatively successful but comparatively false, we can conclude that it was selected from the F-space. The deliberation over whether T is true, or whether it is comparatively true, can be recast as a deliberation over whether it was selected from the T-space or the F-space.

The argument from double spaces is an argument that asks for evidence that it is likely[1] that T was selected from the T-space, and not from the F-space, or for evidence that T was selected from the F-space, and not from the T-space. The burden of providing the evidence falls on those who believe that T has a certain semantic property, whether that semantic property is truth, comparative truth, falsity, comparative falsity, empirical adequacy, comparative empirical adequacy, empirical inadequacy, comparative empirical inadequacy, or what have you. Let me apply the argument from double spaces to scientific realists and antirealists first.

Suppose scientific realists and antirealists observe that T is successful, and then infer that T is true and false, respectively. The argument from double spaces implies that scientific realists' inference requires the prior belief that T was selected from the T-space. It also implies that scientific antirealists' inference requires the prior belief that T was selected from the F-space. In light of this request, scientific antirealists would retreat to the skeptical position that we do not know whether T was selected from the T-space or the F-space, and thus we do not know whether T is true or false. This skeptical position is free from the burden of showing that T was selected from the F-space. By contrast, scientific realists have the burden of showing that T was selected from the T-space.

Let me turn to relative realists and relative antirealists. They observe that T is more successful than its alternative, and then infer that T is comparatively true and comparatively false, respectively. The argument from double spaces implies that relative realists' inference requires the prior belief that T was selected from the T-space, and not from the F-space. It also implies that relative antirealists' inference requires the prior belief that T was selected from the F-space, and not from the T-space. If T were selected from the T-space, its appearance would coincide with its reality, which means that, if it is comparatively successful, it is comparatively

[1] I drop "likely" hereafter for the sake of brevity.

true. By contrast, if T were selected from the F-space, its appearance would not coincide with its reality, which means that, if T is comparatively successful, it is comparatively false. Relative realists have the burden of showing that scientists selected T from the T-space, and not from the F-space. By contrast, relative antirealists have the burden of showing that scientists selected T from the F-space, and not from the T-space. In light of this criticism, relative antirealists would retreat to the skeptical position that we do not know whether T is from the T-space or from the F-space.

How does the argument from double spaces relate to the argument from a bad lot? The argument from a bad lot invokes unconceived alternatives, and then requests evidence that T is better than *unconceived* alternatives. By contrast, the argument from double spaces invokes T-space and F-space, and then requests evidence that T was selected from the T-space or that it was selected from the F-space. Both the T-space and the F-space are inhabited by *unconceived* scientific theories. Therefore, both the argument from a bad lot and the argument from double spaces invoke *unconceived* scientific theories.

However, there is an important difference between the unconceived alternatives in the argument from a bad lot and the unconceived scientific theories in the argument from doubles spaces. The former are alternatives to our best theories, whereas the latter may or may not be. To say that an unconceived scientific theory is in the T-space simply means that it is fated to lead us to true beliefs about itself. To say that an unconceived scientific theory is in the F-space simply means that it is fated to lead us to false beliefs about itself. It is entirely irrelevant whether it is an alternative to a current theory.

There are further similarities between the argument from a bad lot and the argument from doubles spaces. The argument from a bad lot states that, even if T is more successful than all the conceived alternatives, we cannot conclude that it is true because it "may well be the best of a bad lot" (van Fraassen 1989, 143). Note that the argument from a bad lot does not say that it is *likely* that T is the best of a bad lot. It only says that it is *possible* that T is the best of a bad lot. It also claims scientific realists bear the onus of showing that T is not the best of a bad lot, i.e., that T is better than its unconceived alternatives.

Analogously, the argument from double spaces states that, even if T appears to have a certain semantic property, we cannot conclude that it has the semantic property because its appearance *may* be different from its reality, i.e., because T *may* be a selection from the F-space. It does not say that it is *likely* that T was selected from the F-space, but only that it is possible that T was selected from the F-space. It also claims that those who believe that T has a certain semantic property have the burden of showing that T was selected from the T-space.

As readers may have noted, the arguments from a bad lot and from double spaces make demanding requests. The former requests evidence that T is better than its unconceived alternatives. The latter requests evidence that T is from one space, and not from the other. It is beyond my imagination how humans can meet these requests. Only God, who has the cognitive capacity to conceive of all the competitors to T, can meet the demanding request of the argument from a bad lot. Only God, who has the cognitive power to penetrate the appearance of T, can meet the demanding request of the argument from double spaces.

Just as relative realists (RR) run the argument from a bad lot against scientific realism, so scientific realists (SR) can run the argument from double spaces against relative realists. What would happen if they met with each other to debate whether T is true or comparatively true? The following dialogue would likely occur:

> RR: How can you deny that T is comparatively true when it is comparatively successful? It is obvious if it is comparatively successful, it is comparatively true.

SR: How can you deny that T is true when T is successful? It is obvious if T is successful, it is true.

RR: Although T is successful, we cannot conclude it is true because it may be the best of a bad lot.

SR: Although T is comparatively successful, we cannot conclude it is comparatively true because it may be a selection from the F-space.

This imaginary stalemate between scientific and relative realists indicates that those who take the argument from a bad lot to be correct are led to skepticism about whether T has a certain semantic property.

The argument from double spaces can also be turned against empiricism, which this article defines as the position that T is empirically adequate. Empiricists observe that T is successful and then infer that it is empirically adequate. The argument from double spaces implies that empiricists' inference requires the prior belief that T was selected from the T-space. If T were selected from the T-space, its appearance would agree with its reality, which means that, if T is successful, it is empirically adequate. By contrast, if T were selected from the F-space, its appearance would disagree with its reality, which means that, if T is successful, it is empirically inadequate. Empiricists have the burden of showing that T was selected from the T-space.

The argument from double spaces also has a negative implication for the semantic account of scientific progress (Niiniluoto, 1984, 2014). According to the semantic account, "scientific progress can be defined by increasing verisimilitude" (Niiniluoto, 2014, 77). Replacing the geocentric theory with the heliocentric theory was progressive because the heliocentric theory was more verisimilar than the geocentric theory. The argument from double spaces implies that the proponents of the semantic account cannot conclude that the heliocentric theory was more verisimilar than the geocentric theory, although the former was more successful than the latter, because the former may have been selected from the F-space. The onus is on the proponents of the semantic account to show that the heliocentric theory was selected from the T-space.

The argument from double spaces undercuts another account of scientific progress that might be called "the empirical account." It holds that "science makes progress precisely when our theories become increasingly empirically adequate" (Dellsén 2018, Section 6). The advocates of the empirical account observe that the heliocentric theory was more successful than the geocentric theory, and then argue that replacing the geocentric theory with the heliocentric theory was progressive because the heliocentric theory was closer to empirical adequacy than the geocentric theory. The argument from double spaces implies that their inference requires the prior belief that the heliocentric theory was selected from the T-space. To say that the heliocentric theory was selected from the T-space means that, if the heliocentric theory is more successful than its competitor, it is closer to empirical adequacy than its competitor. By contrast, to say that the heliocentric theory was selected from the F-space means that, if it is more successful than its competitor, it is farther from the empirical adequacy than its competitor, i.e., it is comparatively empirically inadequate. The advocates of the empirical account have the burden of showing that the heliocentric theory was selected from the T-space.

The argument from double spaces also works whether T is a scientific theory or a philosophical theory. For example, van Fraassen (1980, 112 & 130–134) claims that his contextual theory is correct, while its competitors (Hempel, 1966; Salmon, 1971; Friedman, 1974) are not, on the grounds that his can explain, while the others cannot, the phenomena in

science called "rejections" and "asymmetries" (Park 2019, 91). In short, after observing that the contextual theory is successful, he infers that it is true. The argument from double spaces implies that his inference requires the prior belief that the contextual theory was selected from the T-space.

This prior belief needs to be established not only by those who believe that the contextual theory is true, but also by those who believe that it is comparatively true, empirically adequate, or comparatively empirically adequate. How does its truth differ from its empirical adequacy?

> The truth of the theory means that an explanation is an answer to a why-question, and that appropriateness of the answer depends on context. The empirical adequacy of the theory, on the other hand, means that what it explains, viz., the phenomena, such as rejections and asymmetries, occur in scientific practices. (Park 2017b, 61)

Those who believe that the contextual theory is empirically adequate, but not true, believe that phenomena such as "rejections" and "asymmetries" occur in science, but not that "An explanation is an answer to a why-question" (van Fraassen 1980, 134). The argument from double spaces implies that the contextual theory, although more successful than its competitors, might be farther from empirical adequacy than they.

In summary, the argument from a bad lot is built upon the idea that there might be unconceived alternatives to T, and the argument from double spaces is built upon the idea that the appearance of T might be misleading, and thus it is legitimate to distinguish between its appearance and its reality. The two arguments can be characterized by the following similar and simple questions: "Is T better than its unconceived alternatives?" and "Is T from the T-space or the F-space?"

Objectors might say that both the argument from a bad lot and the argument from double spaces are merely philosophical fantasies, i.e., they have no bearing on scientific practice. I admit that they have a point. I dare say, however, that the two arguments are similar to each other, as we noted above, so those who defend the argument from a bad lot cannot dismiss the argument from double spaces. They include not only van Fraassen (1989) and Mizrahi (2020) but also James Ladyman et al. (1997), Brad Wray (2008, 2012), and Kareem Khalifa (2010).

6. Conclusion

Scientific realists distinguish between the best of unsuccessful rival theories and the best of successful rival theories. They admit that the former is comparatively true, but not approximately true. However, they insist that the latter is both (approximately) true and comparatively true. By contrast, relative realists do not distinguish between the former and the latter, saying that both are comparatively true, but not approximately true. Relative realists' position is predicated on the argument from a bad lot as well as on their fundamental belief that we cannot make the absolute judgment that T is successful.

Relative realists' fundamental belief clashes with Laudan's definition of success and with those cases in which empirical equivalents are successful. In addition, the argument from double spaces undermines many philosophical inferences, including relative realists' inference, if the argument from a bad lot undermines scientific realists' inference. Given the similarities between the two arguments, it will be difficult for my opponents to show that the argument from a bad lot is strong, while the argument from double spaces is weak. I predict that my opponents' future criticisms against the argument from double spaces will backfire on the argument from a bad lot, and that they will help us see the intrinsic flaws with the argument from a bad lot.

Finally, Mizrahi (2020) has other intriguing objections to scientific realism that he claims do not apply to relative realism. I reserve my responses to them for future occasions.

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