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Convergence argument against the challenge of "unconceived alternative theories"

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ABSTRACT: Kyle Stanford (2001, 2006a) poses a new challenge to scientific realism, known as the "new pessimistic induction." According to him, for each theory chosen by scientists, a class of theories exists with radically distinct ontological claims but equal explanatory power. Therefore, no theory can be considered as the only theory or the best theory. As a result, the realistic approach to its unobservable entities is unjustified. This paper tries to use the idea of convergence against this challenge. The first part of the paper emphasizes that, according to the new pessimistic induction, given the unlimited number of unconceived alternative theories for each successful theory, the possibility of "encountering" and "uniting" independent theories will be very unlikely. Meanwhile, the history of science recurrently displays convergence and multiple discoveries. In the second part, an attempt is made to respond to the general critiques of the idea of convergence.

KEY WORDS: Kyle Stanford, unconceived alternative theories, pessimistic induction, scientific realism, convergence.

1. Introduction

Scientific theories explain empirical phenomena and provide accurate predictions. These theories use unobservable entities to strengthen their explanatory and predictive power. However, does this mean that they also provide a true description of the world? Should we believe in unobservable entities assumed in theories? Here, two groups are distinguished. The first group, proponents of scientific realism (hereafter, realism), believe that the success of a scientific theory rests on the correctness of the reference of its theoretical terms and the reality of the properties and laws attributed to the world (Boyd 1973, 1983; Putnam 1975). In contrast, the other group – antirealists – speaks of the instrumental utility of theory (or its empirical adequacy) to cover more phenomena. The success of a theory does not require an ontological commitment to it (van Fraassen 1980; Laudan 1981; Stanford 2006a). This view conflicts with the realistic intuitions of the general public and the realistic intuitions of the majority of scientists, because they do not consider theoretical entities – such as genes, atoms and quarks to be just artificial tools for simplifying empirical relationships. Realists cite the success of the experimental sciences in explaining, predicting, and making technological advances as evidence of the validity of theories.

This paper tries to defend the realistic approach against one of the recent challenges. In the second section, I will discuss the problem of "unconceived alternative theories" posed by Kyle Stanford as a fundamental challenge to scientific realism. In the third section, I will put forward some crucial criticisms against his approach. The fourth section aims to show that convergence is important (contrary to Stanford's claim) and that the occurrence of a particular type of convergence – the combination of theories and the phenomena of simultaneous discoveries – supports realistic intuitions. In the fifth section, I will try to defend the idea of convergence against the criticisms of Laudan and Stanford.

2. Unconceived alternative theories as new pessimistic induction

Kyle Stanford (2001, 2006a) poses a new challenge to realism, which, in his view, is the strongest argument against it. According to Stanford, the history of science shows that for every dominant theory, in any period, scientists have been able to adopt alternative theories, since in order to explain a phenomenon or a set of phenomena, we come across several theories. These theories all have equal explanatory power based on available evidence but rely on different descriptions of the world, i.e., these possible alternative theories consider different unobservable entities to explain the same phenomena. In such a situation, scientists compare available theories and select the best one. However, the problem is that scientists do not consider all explanatorily equal theories in their final analysis and selection. This inability to conceive or consider all possible theories has many causes: the dogmatism of scientists or the scientific community or the inherent limitations of human creativity (Sklar 1981; Stanford 2001; Stanford 2006a: 17-18). These unconceived theories are not speculative (Stanford 2001) because the history of science shows that the real possibilities have been neglected and unconceived by scientists during every age and period. So, unconceived alternative theories are not constructed employing logical-technical tricks and manipulation of current theories; instead, they are genuine theories presenting truly distinct perspectives. For example, the theory of general relativity for Aristotelian philosophers and Newtonian tradition was incomprehensible. However, it falls into the category of theories that could explain the familiar phenomena of "falling rocks" and "the movement of celestial bodies."

From the perspective of this pessimism, the history of science shows that correct theories were not even on the horizon of scientists of earlier periods. It also shows that some later-accepted theories were introduced to the scientific community during earlier periods but were deemed unworthy of consideration at the time (for examples, see Stanford 2006a: ch 3). This inability to grasp all logically possible theories in any particular field and take them seriously has appeared throughout the history of science. Therefore, there is no reason why it should not be happening for current theories. For this reason, this challenge is also called the "recurrent, transient underdetermination" (Stanford 2006a: 17). As a result, we cannot assume that our theory is the only possible theory or even the best among several others. Also, the success of our theory can – and certainly will – be challenged by other theories that have not yet been conceived. As a result, theoretical terms that refer to unobservable entities cannot be considered as the real descriptions of the world.

Stanford (2006a: 18, 23) calls his approach *the new* pessimistic induction, as opposed to the traditional or old pessimistic induction. By criticizing the "non-miracle" argument, the old pessimistic induction states that "correct reference of theoretical terms" is not the only plausible explanation for the "success of theory" (Laudan 1981) because the abandoned theories in the history of science, with their presupposed entities now being eliminated, were successful in their time. "Celestial spheres" in Ptolemy's astronomical theory, the "phlogiston" in chemistry, and the "ether" in classical mechanics are all examples of rejected entities in the history of science. Therefore, the success of a current theory does not support the realistic attitude regarding its unobservable entities.

Stanford's usage of historical examples to discourage realistic tendencies is similar to Laudan's induction. However, the basis of Stanford's approach is not "the failure of past successful theories." "Old induction" is criticized because past failed theories have not been mature enough or had little "empirical success" (Stanford 2001). Another criticism is that the "degrees or varieties" of success in different theories in "old induction" are vague, making it difficult to extend the failures of old theories to new ones (Stanford 2006b). The "new pessimistic approach," according to Stanford, emphasizes only that the realist cannot prove that a current theory is the best or the only possible theory for explaining any given phenomena because there are always unconceived alternative theories. Even if a theory does not fail, there are better theories that have not yet been conceived.

3. Objections against new pessimism

One line of argument against Stanford's challenge can be based on the distinction between two domains. The first domain are the meta-scientific studies that explore science and its development from a historical and philosophical point of view. In contrast, the second domain focuses on actual or real-time scientific activity. The abstract "philosophical problem" of unconceived alternative theories (and other similar objections) should be separated from scientists' concrete understanding coming from their operational involvement in the laboratory environment, mathematical analysis, communication with other scientists, and dealing with specific issues in the field of study. For example, Zamora Bonilla (2019) states that taking a stand against unobservable entities is essentially an internal issue: in various theorizing phases, scientists are free to adopt an instrumentalist or realistic view to be more productive.

Furthermore, there is no final and external judgment on this issue from the point of view of meta-scientific studies. According to Saatsi (2017, 2019), we should put aside the ambition to define explicit "recipes" of entities. Instead, we should try to maintain *minimal realism*, which means the justified commitment to our current successful theories that are much more empirically successful than the previous ones, because the reason for this increase in empirical power is that they relate more successfully (although in a complex way) to the real world. He says that due to the rich connections between theories and the increased predictive power of a current theory compared to the former theory, it is possible to use the "non-miracle" argument to defend the current theory as being closer to the truth (in terms of its better "latching onto reality"). Along the same lines, Mizrahi (2016) suggests that Stanford's philosophical analysis could be challenged in its terms, i.e., the new pessimistic induction itself could become the subject of "unconceived objection" and "probable conclusive refutation." In other words, possible responses to it may be revealed by philosophers and scientists in the future. Therefore, this new pessimistic induction cannot be considered as a definitive rejection of realism.

Another important response to the unconceived alternative argument is to emphasize the fundamental differences between past and present periods in the history of science. Proponents of realism emphasize that theoretical developments and innovations in the twentieth century differ from the entire history of science in terms of their quantity, quality, and durability. For this reason, the verdict resulting from the failures of scientific theories in previous periods cannot be extended to the current period.

In this progressive path of the history of science, we encounter powerful theories by using more advanced technical tools and more awareness of the methodology of science. As Devitt (2011) points out, current theories are in a privileged position, and the pessimistic induction based on historical cases of failed theories cannot be easily generalized. Current science is sharply distinct from past science in terms of experimental technologies and methodological studies, so we are now more capable of identifying and enumerating alternative theories. Ruhmkorff (2011) argues that the impossibility of enumerating all possible theories due to the weakness of human cognitive abilities does not mean that there are countless alternative theories for each theory.

4. Convergence against the unconceived alternative argument

In this section, I will try to challenge the unconceived alternative theories argument and defend the realist intuition about scientific theories. By "realist intuition" I mean the belief that there is a significant relationship between empirically successful theories and their approximate truths. On a realistic reading, different theories should be able to be integrated into an exhaustive framework. Scientific theories truly deal with reality, and the basic infrastructure of the universe is unique. Accordingly, one can expect that our well-confirmed theory and its unconceived alternative theories will gradually converge and link with each other in one theoretical framework despite their initial differences and divergence. Now, we ask how theories formulated in various branches of one science, such as physics, relate to each other if pessimistic induction is correct.

To begin with, Stanford's argument can be summarized as follows: *For each theory chosen by scientists, a class of theories is logically possible with radically different ontological claims equal in terms of explanatory power.*

Therefore, no theory can be considered as the only theory or the best theory. As a result, the realistic approach to the unobservable entities is unjustified.

We will first list three fundamental assumptions of the unconceived alternative theory approach:

S1. There are many unconceived alternative theories.
S2. These alternative theories are radically different.
S3. Therefore, based on S1 and S2, every chosen theory is most likely false.

To begin the discussion, imagine three empirical phenomena: *a*, *b,* and *c* (*explananda*). According to Stanford's approach to explaining these phenomena, there is a class of theories that some scientists enumerate and select among. But how many alternative theories have not been conceived? It can be easily claimed, a lot, because a theory is entirely free from objective constraints. Therefore, due to the extensive number of logically possible theories, it is very unlikely that the current theory is conceived and selected among many unconceived theories. This theory is not subject to any kind of objective necessity (in its use of theoretical terms), and other theories could be selected too since all of them are equally warranted by available evidence.

Suppose that theory T1 is chosen to explain phenomena *a*, *b*, and *c* and that it makes successful predictions. According to the approach of unconceived alternative theories, the probability of its truth (due to the freedom to construct theories) against the infinite number of alternative theories is very small. Now suppose that, in another context and time, theory T2 is formulated independently of T1 to explain phenomena *d*, *e*, and *f*. The probability of its truth is also very low for the same reason as mentioned for T1. (To simplify the situation, we will consider only two theories). Now, is it possible that these two theories combine fundamentally in a more inclusive theory (T*) that is more powerful in terms of prediction and explanatory power? Given the three mentioned assumptions of Stanford's challenge, the probability of this kind of unification is incredibly low. How can several theories that are very likely to be wrong work together to construct a more empirically successful theory?

$$P(T1) = \frac{1}{\text{possible explanations for a, b and c}} = \varepsilon$$

$$P(T2) = \frac{1}{\text{possible explanations for d, e and f}} = \varepsilon$$

$P(T^*) = \varepsilon \times \varepsilon$

* P = probability of truth for the selected theory

However, throughout the history of science, we have repeatedly seen theories that have been developed independently and have later been grouped into more comprehensive theories. They have dealt with different phenomena and addressed different questions, and each had its own evidence. Yet, they have been synergistically formulated together into new, more powerful theories. What has brought these independent efforts to eventually unite as parts of a comprehensive framework? According to the pessimistic approach, the probability of this merging is extremely low – the fact that theories do merge is almost miraculous. Suppose we do not accept that something common and objective – something beyond the free imagination of scientists – is responsible for the possibility of their compatibility and unity. In that case, we cannot analyze this connection.

It should be noted that we do not speak of interpreting the convergence as logical conjunction (i.e., $T^* = T1 \ \& \ T2$). Firstly, logical conjunction does not improve the epistemic status of theories separately since their combination is a technical issue, not an unexpected event. Secondly, the consistency of successful theories is not the only feature of unifications found in the history of science (van Fraassen 1980: 85-88). This is because the juxtaposition of different theories does not extend their explanatory power to cover a new field of phenomena, nor does it bring about novel predictions. So, a convergent theory is not a chain of sub-theories but rather a fruitful combination resulting in a comprehensive theory.

Here we can also mention some controversial examples from recent discussions of "truthlikeness" (Niiniluoto 2020) and show that they are practically not a threat to our argument.[1] The question is this: is it possible for two false theories – or for one true and one false theory – to merge, and we mistakenly interpret this combination as their approximate truth and consider the combined theory as progress to the truth (as we move away from the truth)? For example, we consider two simplified possibilities for combining theories. In the first case, considering the

[1] It should be mentioned that our main aim is to generally defend the realistic intuition, that is, the meaningful connection between experiential success and truth. We do not intend to turn this intuition into a tool for quantitatively estimating the approximation to the truth or achieving an objective criterion for deciding between rival theories.

correct answer N = 8 for the number of planets in the solar system, we examine the conjunction of two false theories:

T1 = (N = 7 v N = 20)
T2 = (N = 7)

T* = T1 & T2

As we can see, the two theories, both of which are false, seem interconnected. Therefore, the "possibility of connection" can also occur for completely false theories. In response, it should be said that our discussion is not about the possible overlap of purely conjectural claims. Instead, it is a question of the combinability of empirically successful theories. In other words, these two theories (T1 and T2) either have not been tested empirically or their predictions failed. In both cases, there is no empirical success. Secondly, their combination is also not empirically fruitful (obviously). In another example, the combination of a true and a false theory decreases the truthlikeness of the combined theory. For example:

T1 = (N = 7 v N = 20)
T3 = (N > 7)
T* = T1 & T3

Due to the reasons mentioned above, this example also does not pose a problem for our discussion. Conversely, these examples show that the central issue of our argument – i.e., the meaningful relationship between empirical success and truth – can lead to contradiction if not taken as a fundamental condition.

To make our claim more tangible, we can look at the history of the 17th-century scientific revolution, which consisted of various attempts that took a long time to bear fruit: Copernicus' brilliant insight, Tycho Brahe's detailed information of planetary orbits, Kepler's laws, Galileo's observations with powerful telescopes, and the analysis of acceleration/velocity of objects in free fall/sloping surfaces that led to Newton's masterpiece. The history of science shows how, in this arduous process, the nuts and bolts of Aristotelian cosmology – the theory of the planets, the four causes, the separation of the region above and below the moon, natural place, and so on – were unraveled and removed from modern science by various scientists, including Newton. It was as if all these scientists were unknowingly working on a single program.

Although this inevitable convergence of theories seems like pure optimism, it has occurred repeatedly throughout the history of science. As Popper says:

> The theories of Kepler and Galileo were unified and superseded by Newton's logically stronger and better testable theory, and similarly Fresnel's and Faraday's by Maxwell's. Newton's theory, and Maxwell's, in their turn, were unified and superseded by Einstein's. In each such case, the progress was towards a more informative and therefore logically less probable theory. (Popper 2002: 298)

The above examples can be called "unexpected unification," which focuses on fruitful unification of different sub-theories to bring about more powerful theories. Another set of examples, showing that theoretical terms are not picked up from the ocean of possible theories by pure chance, are historical phenomena that are famous as "multiple discoveries" (Merton 1973: 357-360). The history of science is full of discoveries and innovations that different scientists have made without knowing each other's activities. There is a long list of independent simultaneous discoveries in the history of science (for a list of 148 such discoveries and innovations, see Ogburn and Thomas 1922), from which only three will be mentioned here: 1) C. W. Scheele, J. Priestley, and A. Lavoisier on the discovery of oxygen during 1774–1777, 2) Colding, Mayer, Joule, and Helmholtz on energy conservation during 1842–1847 (see Kuhn 1977: ch. 4), and 3) Hugo DeVries, Carl Correns, and Erich von Tschermak on the rediscovery of Mendel's laws of inheritance in 1900 (Ogburn and Thomas 1922).

For example, Kuhn (1977: ch. 4) shows how the law of conservation of energy is expressed by scientists of different origins and in various fields of research. He refers to three effective areas from which scientists come up with this idea: *study on conversion processes*, *study on engines*, and *natural philosophy*. New experiments in the transformation of magnetic, electrical, mechanical, and thermal phenomena have brought some scientists closer to the idea of the "correlation of physical forces." Others paved the way for the quantification analysis of "energy" by studying the performance of electric and steam motors, with a focus on the concept of "work." On the other side, natural philosophers of the 19th century searched for a unifying principle for all natural phenomena. For this reason, they believed that there is a single force that all other types of forces are, in fact, different aspects of that force. Eventually, the *conservation* principle, as the crossroads of all these efforts and insights, was established as an important feature of the world. And there are a lot of examples in history.

These examples support the belief in the approximate truth of successful theories or their gradual advancement towards the truth. Here, an important critique should be answered. The critique says convergence is practically trivial because the successor theory can easily be created by preserving the wrong entities of the predecessor theory while somehow extending the theory's power (Stanford 2006a: 168). So, convergence does not prove anything.

By convergence, Stanford means connection of two successive theories. Rather, our argument is based on a fertile combination of different independent, successful theories to form a single theory. Besides, these sub-theories are often unknown to each other in the formation phase, so this convergence/combination cannot be made by technical tricks. Therefore, the convergence that we mentioned is an important event implying the significant relation of "empirical success" and "approximate truth."

We should note that the "convergence" does not secure the reference of theoretical terms, nor does the "unity" serve as a criterion for conclusive confirmation of the theory. What matters to us is that this occurrence conflicts with the new pessimistic induction. Our argument in this section is as follows:

(a) The convergence of theories in the history of science, considering that most theories are false, is very unlikely.
(b) Convergence takes place in the history of science repeatedly.

(RC: realism from convergence) What made these theories converge in a fruitful way (and caused simultaneous discoveries) is something common, fundamental, and outside the theory.

One issue here should be cleared up. Stanford's argument is about theories explaining the same set of phenomena; they belong to one particular branch of science (e.g., theories explaining electrical phenomena). However, the convergence we present is the connection of theories from different branches (e.g., uniting the electronic theory with magnetic theory in shaping electromagnetics). Due to these unifications in history, we argued that the assumptions S1 and S2 face many counterexamples (i.e., intersected and converged theories). These intersections occur between theories that were either unknown or considered to belong to different fields. We claimed that, without a realistic attitude, we could not explain their convergence.

However, there are some possible objections to our arguments. If successful theories inevitably meet each other, why are there distinct successful theories (in one special field of study or different branches) with irreconcilable differences (e.g., quantum mechanics and Newtonian mechanics)? If something "common, fundamental, and outside the theory" makes them successful, how are they radically distinct?

To answer this challenge, we can say that there would be an unconceived, comprehensive, and inclusive theory in which seemingly fundamental and irreversible distinctions may be understood as the different aspects of a common entity, or they can be merged via some corrections. This possibility does not represent a vain optimistic view, and we can support it with real historical examples. A good example is the contradictory and inconsistent ideas of Leibniz and Newton on the reality of space. Although the two theories are clearly in conflict (Newton believed in the absoluteness of prefabricated space as the container for all spatial variation, whereas Leibniz saw space as a mental construction of objective relations between objects), we can see their fruitful combination in general relativity. We have a relativistic understanding of time and space plus equations that can be reduced to Newtonian equations. Thus, it seems that two contradictory approaches have been successfully integrated into a comprehensive theory in terms of the development of predictive and explanatory power.

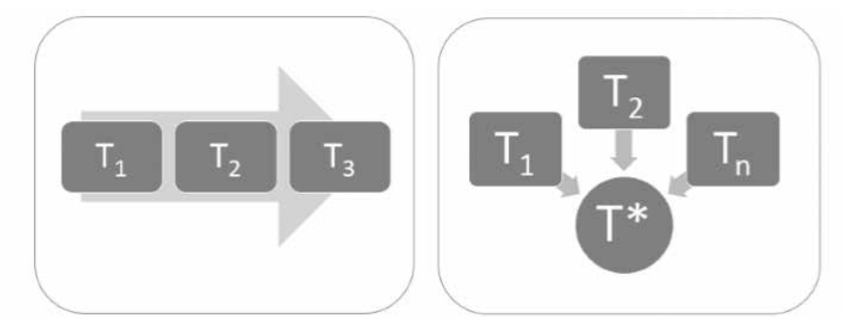
For another example, we can look at the contrast between the particle/wave hypotheses concerning light. These two theories, both of which are explanatory theories about the shared entity of light, were regarded as competing theories before they were both incorporated into quantum mechanics. Another example comes from two currently competing theories: string theory and quantum loop theory. These two theories include different claims and assumptions, yet some investigations (e.g., Vaid 2018) show that they might be two sides of the same coin. As a result, the technical term "radical distinction" in S2 is highly vague because "distinctness" is highly dependent on our incomplete theory. Therefore, the existence of different successful theories does not challenge our argument.

Nevertheless, our argument could be challenged from two different perspectives. First, other theories, such as T^{ua} (an unconceived alternative theory), may combine successful theories more effectively than T^{*} (and possibly produce better results). Second, it could be argued that most of the theories of various historical periods, which can be considered interconnected by other sub-theories, are theories that were incorrectly discarded (such as Aristotle's or Newton's theories). These objections would weaken our claim if we assumed that the convergence secures reference or that our theory is complete (which we did not). We claim that there might be parallel paths and possible unconceived theories, or perhaps some wrong entity, rule, or assumption in our theory. However, the inclusive converged theory is still on the right track of the true description of the world. To defend this claim, we need to show that the relationship between success and truth (i.e., the realist intuition) would be maintained during convergence. For this purpose, we will deal with the objection against the idea of convergence.

5. Defending convergence

As already mentioned, by "convergence," we mean a set of theories that unexpectedly come together in the form of a more comprehensive theory or a common discovery. This conception of convergence, which can be called "cluster convergence," is different from the conventional reading of convergence, which can be called "linear convergence." They can be represented schematically as follows:

Two models of convergence



Linear convergence Cluster convergence

We can see here how our core argument differs from conventional quantitative truthlikeness approaches. Attempts to quantify the convergence of scientific theory – i.e., measuring the distance from the True Theory – are difficult, mainly because we are always unaware of the unobservable entities that really exist (the True Theory). Therefore, there is no objective ground for linking "the increase in the degree of belief" (due to the empirical successfulness) to the real truthlikeness. Also, the empirical achievements of theories (e.g., their explanatory improvement and increase of predictive accuracy) can be explained in antirealist terms (Roselli 2020). However, for a realist, antirealist explanations are more like tautologies and have virtually no explanatory value (Niiniluoto 2017). Regardless of the possibility of explaining the success of science in the antirealist approach, this line of criticism would not affect our claim. It was stated in the previous section that successful theories combined into a more fruitful theory ("cluster convergence") could not be explained without considering an objective common cause. We are not inferring "a theory converging to the Truth" because of its empirical successfulness but explain "the convergence of empirically successful theories due to their partially true content." Therefore, "cluster convergence" is more robust because the elements of our convergence are available in the history of science (unlike the first case, in which the main element of convergence, the True Theory, is absent). Also, contrary to "linear convergence", "cluster convergence" cannot be created by technical manipulation.

By the way, our realist intuition is modest because it does not deduce the theory's truth from its increasing empirical power. It also does not negate other possibilities and possibly better-unconceived theories. But we do reject the claim that the process of combining and correcting our accepted theory may take us "away" from the truth in the sense that realistic intuition is violated. In the next section, we will address the critique of the idea of convergence and show that it does not affect significant implications of convergence in defending the realist intuition.

5.1. *Convergence is not accumulation*

For Laudan (1981), the convergence-based argument for realism is the following: "The 'fact' that scientists succeed at retaining appropriate parts of earlier theories in more successful successors shows that the earlier theories did genuinely refer and that they were approximately true." To challenge this argument, he mentions that, in many cases, the convergence or *being a limiting case of another theory* happens along with obvious changes in unobservable entities of the two theories. In other words, there is a definite difference between the unobservable entities of T1 (as one of the unified components) and T*. So, either there is no convergence at all or the connection between successive theories is inconsistent with the desired result of the argument (i.e., RC). Laudan specifies two conditions for convergence that can be called the cumulative model of convergence:

(1) Successful theories must have common entities.
(2) Comprehensive theories must include the entities of the previous theory.

It is clear that the history of science frequently violates such an accumulative pattern of convergence. As Laudan exemplifies this: in the transition from Newton's theory to Einstein's theory, we see, in fact, the explicit removal of the ether (and with the removal of the ether, all related laws were removed too). Thus, the increase in predictive power is associated with explicit changes regarding some entities. As a result, there is no convergence between theories throughout history because they have different entities. We can see multiple independent theories with different unobservable entities throughout the history of science. To support this idea, Laudan presents a list of rejected and obsolete entities (i.e., those that were not preserved and restored in later successful theories) among previously successful theories to show the possibility of (A) to refute RC:

(A) The success of theory and the failure of the assumed unobservable entity to refer.[2]

We should say, however, that his analysis and examples do not undermine RC. These examples could undermine realism if and only if the success of a theory was necessarily the product of the function of the discarded unobservable entities. But the history of science shows the opposite: the failure of a previous theory is due to its erroneous entity. The discarded entity is the cause of the theory's limitations in prediction and explanation. Using Kitcher's (2001) terms, "working posits" should be distinguished from "idle wheels" in the analysis of a theory. Working posit has an effectively positive function in the success of a theory, which survives the transition. But the discarded entities are redundant, idle,

[2] It shows that two historical pessimistic inductions have a common root. The "old pessimistic induction" claims that *no matter how successful a theory is, it will eventually fail,* and Stanford's "new pessimistic induction" states that *a theory can be untrue but successful enough*. Both inductions – although different – are based on the assumption that "the success of a theory" and "theoretical terms with no correct reference" are possible.

or kind of a barrier. In this way, the realist believes that assuming the right entities (or rejecting false ones) will lead to the success of a theory. Therefore, changing the entities during a transition does not violate RC.

5.2. *Prospective convergence versus retrospective convergence*

The general response to Laudan's challenge is that realism-based intuition persisted because rejected entities played no role in the theory's success. However, to defend this view, we must have an objective criterion that allows us to separate the positively effective parts of the theory from its redundant parts. In Laudan's (1981) view, this distinction is not possible because the totality of the theory might be confirmed or refuted, and it is not possible to distinguish the true parts from the false parts. Another objection, made by Stanford (2006a: 168), is that we must have a definitely applicable prospective criterion to make this separation. Otherwise, our separation of the effective and redundant parts of the old theory depends on the current theory's validity, but the truth of the current theory itself is questionable. As Stanford challenges the "selective confirmation" approach:

> But as it stands this appeal to the strategy of selective confirmation faces a crucial problem that appears to be unrecognized by its architects: of any past successful theory the realist asks "what parts of it were true?" and "what parts were responsible for its success?" but both questions are answered by appeal to our own present theoretical beliefs about the world. (Stanford 2006a: 166)

Stanford's objection can be rewritten as follows:

(1) T1 provides successful predictions with a set of unobservable entities.
(2) T* excludes some unobservable entities of T1 and preserves some other parts and provides more accurate predictions.

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(3) Consequence of the convergence proponents: The relationship between success and truth is maintained.
(4) Consequence of the antirealist critic: The criterion for preserving/omitting some parts of T1 depends on the unjustified acceptance of the truth of T*. Therefore, this separation is not prospectively applicable.

To meet this challenge, we should first consider that it is impossible to go beyond the theory and examine the relationship between its terms and reality. It is too much to expect from a philosopher to meet the explicit conditions for determining the entity that carries the burden of the success of a theory, and the defenders should not make such an unreasonable request of realism (Saatsi 2017) because this is the scientific activity that scientists do in the scientific space. Nevertheless, Stanford's epistemological challenge persists because the defense of convergence practically requires entities to be separated independently of the current theory. From the antirealist point of view, the assumption that the current theory is true is questionable itself.

To respond to this objection, the transition process from the predecessor theory to the successor theory must be re-examined. Here we use Kuhn's analysis of the formation of scientific theories. First of all, each theory is a historical phenomenon, and we do not have direct access to its complete and logical formulation at the beginning. In the process of refinement and development, the theory matures, and its ontological commitments are identified. Then, among all the discrepancies between the claims of theory and the results of experiments, particular dilemmas become unresolved and permanent. This problem, which is the main cause of scientific crises (and subsequent revolutions), has been called "persistent and recognized anomalies" by Kuhn (1996: 81-82). These anomalies resist all solutions and gradually shake the scientific faith of scientists. Persistent anomaly is a problem that cannot be formulated/conceptualized or explained/predicted using current theories.

These conflicts are created either by independent experiments or by the clash of two successful independent theories, T1 and T2. For example, the celestial sphere was eliminated following the observation of a comet. It was then that the notion of impenetrable unobservable crystalized sphere was virtually dispelled (Rosen 1985; this was before the creation of Newton's theory). Also, the burning of magnesium, and the oxidation process of metals in general with their weight gain, put the idea of phlogiston into serious jeopardy (Blumenthal and Ladyman 2017; this was before the discovery of oxygen).

When it comes to ether, we can see clearly how RC has been considered as a condition to preserve or discard entities. One of the factors that aroused scientists' sensitivity to ether was the conflict between Maxwell's electromagnetic laws and Galilean-Newtonian transformations. Since electromagnetic phenomena did not appear to be invariant under Galilean transformations, independent experimental tests were designed to confirm the presence of ether. One of the most famous and probably the most effective of these tests was the Michelson–Morley experiment, which sought to discover the effect of Earth's motion (relative to the ether) on the speed of light. The result of this experiment was that the motion of the Earth did not affect the speed of light propagation, so it confirmed the stability of the speed of light regardless of the speed of the observer (Einstein 2001: 54). Consequently, but not directly, the failure of several experiments prepared the groundwork for special relativity in 1905. As a result, by removing the concept of "stationary ether" (a privileged framework used to measure absolute velocity in Newtonian mechanics), its relevant property and concepts of "immobility", "absolute space", and "absolute time" were also discarded. Consequently, the limitation of Newtonian mechanics in covering electromagnetic phenomena stepped down.

The process of selecting the effective parts from the redundant parts of theories is, in some cases, due to the realistic assumption, or what we call the realistic intuition: successful theories should at least be consistent.[3] This obligation is essential for conflict resolution. Otherwise, the history of science would be full of distinct theories for which no attempt was made to resolve their conflicts with each other or to overcome their failures. In addition, the antirealist is forced to accept this assumption and the conclusiveness of independent tests to refute wrong entities. Otherwise, Laudan cannot provide his list of examples of failed entities, like the sphere, ether, or pangenesis. In other words, if he does not accept the definitive refutation of the entity, the validity of the premise of his own argument will be questioned.[4]

However, in the causal approach, independent and theory-free experiments also play an essential role in defending realism. For example, regardless of the characteristics defined for the hypothetical entity X and its related laws, a scientist tries to prove the "existence" of X by setting up special experiments directed to X. Stanford considers such an approach unsuccessful in defending realism. His critique is that the separation of an entity from the general theoretical context and the subsequent attempt to prove this entity individually (through separate experiments) might prove the "existence" of the entity as a "thing" in the

[3] Of course, this assumption of realism must be separated from the dogma of realism, which leads to the belief in "the true reference of the terms of current theory" or "its completeness."

[4] As Popper (2002: 149-153) points out, the theory will not be effectively refuted by accepting an instrumentalist/antirealist interpretation.

world, but this process sterilizes the theoretical aspect of the entity. The theoretical aspect refers to the relations of features and rules attributed to the entity with other components of the theory, which together are considered to be the reason for the success of the theory. By eliminating the theoretical aspect, the relation between the unobservable entity and empirical success is practically broken (Stanford 2006a: 147-155). So, the causal approach does not support realist intuition, which seeks to prove a significant relationship between the empirical success of a theory and the existence of an unobservable entity. But Stanford's critique of the causal approach does not affect our analysis because we satisfied the necessary relation of success and truth in the "logical equivalent" of realist intuition: discarded entities have no bearing on the theory's success.[5]

Therefore, the non-theoretical nature of the annulment of an entity makes it possible to distinguish essential parts from redundant parts. This differentiation does not occur retrospectively based on the next theory; inversely, the crisis in predecessor theories leads to the formation of the successor theory prospectively. It means that inconsistencies of successful theories or internal anomalies discovered by experimental tests form the "phenomenological space" effective in forming the following theory. This space, open to scientists, differs from the abstract and unlimited "logical space" for theorizing, assumed in new pessimistic induction. Stanford considers theories as such shaped by ahistorical conjectures. This picture does not correspond to the history and the actual situation of science. According to Kuhn, recognizing the limitations of the former paradigm made scientists wait for a novel phenomenon. As he says: "Discovery commences with the awareness of anomaly, i.e., with the recognition that

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[5] This process of correcting the theory by a definite falsification seems to be one of the almost undisputed cases that increase the truth. Two logical formulations can be considered here. The first is that the theory contains disjunctive constituents, which, according to Niiniluoto (2011, 2020), is the "safest case" that correcting a belief guarantees the increase of truth.

$$T1 = (N = 7 \vee N = 20 \vee N = 13)$$
$$T2 = (N \neq 13)$$
$$T^* = T1 \,\&\, T2 = (N = 7 \vee N = 20)$$

In other words, the omission of an incorrect constituent, which is the product of a combination of T1 and T2, has clearly brought T* closer to the truth. In another case, the theory consists of conjunctive constituents. In this case, according to the different criteria, such as *the min-sum-average* function, getting closer to the truth is still slightly visible. For example, considering the theory T = R & W & P as a completely true theory, we can compare their truthlikeness as Tr (R&W) > Tr (R & W & -w). In other words, by refuting and omitting (-w), the degree of truthfulness of the theory increased (Oddie 2016).

nature has somehow violated the paradigm-induced expectations that govern normal science" (Kuhn 1996: 52). For this reason, our convergence is different from what Stanford (2006a: 166) calls "retrospective convergence" and may be called "prospective convergence."

In a nutshell, examples of failed theories would not affect the convergence of sub-theories and simultaneous discoveries. "The preservation of all entities in the successor theory" (presupposed in the simplified accumulative picture of science) is not the only option for convergence to survive. A new theory will be proposed, while failures, limitations, or conflicts of the previous theories have been recognized. The newly accepted theory successfully goes beyond the limitations and conflicts associated with its predecessor. During this transition, some entities are omitted, while some new ones are introduced. However, as already mentioned, this change, according to an ontological claim, would maintain the realist intuition because omitting an entity means omitting a barrier. Attempts to resolve inconsistencies between successful theories show that realist intuition is a working assumption.

Such a defense of convergence is not based on finding something common and repetitive among all scientific theories (an entity or a mathematical structure). Our discussion shows a chain of continuous cases of convergence in the history of science and that realistic intuition is maintained at every point of connection between transitions. Therefore, there may be more successful alternatives than the current theory. Perhaps the current theory is limited or incomplete in some respects; however, the path and process of scientific activity and theorizing guarantee its closeness to the truth.[6]

[6] Actually, we see a dual function of history that goes back to Duhem's historical analysis. One part of his analysis is the main source of Stanford's (2006: 27-28) challenge: the history of science shows that emergence and development of scientific theories are not necessary. The power (or limitation) of scientists' creativity also plays an essential role in creating theories. However, the history of science also shows a kind of connection between the activities and hypotheses of scientists. This part is missing in Stanford's approach. As Duhem writes: "And, on the other hand, by unrolling before him the continuous tradition through which the science of each epoch is nourished by the systems of past centuries, through which it is pregnant with the physics of the future; by mentioning to him the predictions that theory has formulated and experiment realized: by these it creates and fortifies in him that conviction that physical theory is not merely an artificial system, suitable today and useless tomorrow, but that it is an increasingly more natural classification and an increasingly clearer reflection of realities which experimental method cannot contemplate directly" (Duhem 1982: 270).

7. Concluding remarks

To summarize, the "convergence" we were considering are recurring and unexpected convergences in the history of science that cannot be explained by the assumptions of the argument of unconceived alternative theories. It is highly unlikely that independent false theories can be unified in a way that increases their predictive power without approaching a common external cause. Convergence does not occur only between the successor and the predecessor theories. Also, it is not the result of the conjunction of successful theories. These types of convergence can be forged, i.e., they can be constructed technically. What we mean is a fruitful combination of predecessor sub-theories in shaping the successful successor. Concerning the current competing theories, and given the imperfection of scientific theories, it is possible for scientists to combine them into a more complete theory while making some probable corrections, just as it was done with seemingly conflicting theories that were later combined.

It was also stated that "the existence of more successful unconceived theories" or "the possible shortcomings of the converged theory" does not lead to the negation of its approximate truth. It was argued that ontological changes during convergence do not contradict realistic intuition because they do not commit us to preserve all previous entities in the new theory. This is because omitting/introducing entities with increasing predictive power still does not negate the existence of a common external cause as the axis of convergence. It was also mentioned that discarded entities were the cause of limitation for the empirical power of theories and not the cause of their success. The critical point of the convergence formulated here is that it does not depend on an unjustified belief about the truth of the new theory. *Any inconsistency between two successful theories or the theory-free evidence of independent experiments* leads to the refinement of theories from redundant entities and their related laws. Passing along this separation – i.e., redundant parts vs. positively effective parts – from predecessor theories to new theories, while increasing the predictive and explanatory power of new theories, is what we meant by closeness to the truth. Therefore, realistic intuition will not be violated because convergence is a separation-preserving transition. Besides, in some cases, the reason for removing redundant elements is the need for successful theories to be compatible with each other. It is assumed that successful theories in principle should be convergent.

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