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# Theoretical assessment plan: An overview of a new method for probing theories

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## Abstract

Science is a complex entity. It is made up of theories which are themselves complex entities. Scientists and philosophers have tried to explore them and have come up with pretty, fanciful descriptions. Nevertheless, theories do not exist in a vacuum but are linked to each other in a vast net of other theories forming a view of the world. As theories are made up of core hypothesis, which are "central" and most important, they are surrounded by less important peripheral assumptions which can be changed over time to adapt to the experimental data without affecting key parts of the theory. Theories has been shown to transverse history by modifying their peripheral assumptions but not their basic ones (core), unless there is a major paradigm shift in the community of scientists utilizing this theory. At this point the theory is ejected by a community and substituted by a more up-to-date one which better matches (explains) the experimental data. So, it seems that a scientific community can change the hypotheses at the core (T1 with C1) to obtain new theories (T2 with C2), and at the periphery (C1V1) to obtain better versions of the same basic theory (C1V2, etc.). And even more so when different theories (T1, T2, etc) coexist at the same time in different communities. But how to probe two or more theories, if opposing, to identify the better (more truthful) ones? A plan is needed (theoretical assessment plan, or TAP) to review the hypotheses of each and identify which has more provable/proven assumptions, all other things being equal (i.e., data prediction). Hence, the theory with less unproven hypotheses will be the better one and the scientific community should accept this one and discard the latter. Whether this can occur in history is another question, altogether. The methodology of TAP is proposed and a few historical examples are detailed.

**Keywords:** philosophy of science, theory nets, commensurability, theory testing, core and periphery hypothesis

## Introduction

Nowadays, science is often considered by the layman as the ultimate achievement of mankind for knowledge. Scientific theories are held to be the absolute truth and capable of explaining everything in nature. A different picture, though, is now available to the experts but not to the laymen. This image of science was deconstructed by the all-reaching lens of philosophy of science.

To the question "What is science?" we would not expect a simple and precise answer (Suppes, 1967) [40].

Science is, according to the Science Council (Science Council, 2017), the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. This definition of science does not actually give a clear idea of what it does or does not account for (in terms of the goals of science). Yet, Losee (2001, pg. 2) [20]. Gives a more straightforward definition of science, without spelling it out completely, as the enterprise to explain facts in nature.

But what is really science and a scientific theory?

There is no clear-cut definition of what a scientific theory is. As acknowledged by Chakravartty (2001) [7]. there are several views that have been proposed regarding the essence of a theory. In particular, the author describes two views:

1. One is a perspective generally associated with logical empiricism, also known as syntactic view, or the famous 'received view' (RV), is that a theory is an axiomatic system (placing the emphasis on mathematical rigor), closed under deduction, expressible in a formal language (of symbols, formation and deduction rules), whose elements are characterized by a syntactical structure (Halvorson, 2015) [12]. This structure is the logical calculus (first order predicate calculus or higher order logics), seen as a set of rules for manipulating symbols.
2. Conversely, the semantic view, SV, (or model-theoretic view, taken from the formal semantics or model theory in mathematics) identifies theories in a rather abstract form, that is, in the form of set-theoretic entities – models (systems that satisfy theoretical laws) and their linguistic formulations (reference to a language), given at the time of a (formal) semantic interpretation.

The first approach, which has supposedly been abandoned by now, purports the formalization of science (rational reconstruction) attempted by the logical positivists (culminating with Carnap and Hempel), but has encountered many adversaries in philosophy especially in the 1960s. The problem of the syntactic view is that it is axiomatic and therefore simply implausible. It has largely been supplanted by the so-called semantic view of theories (Klien, 2010).

In the semantic conception, which is composed of different conceptions of scientific theories, such as the state spaces approach of Bas van Fraassen, the phase spaces approach of Frederick Suppe, the set-theoretical approach of Suppes, and the structuralist view of Sneed and other European versions of the same (Lorenzano, 2013) [19]. another formalization is proposed where models are mathematical structures, called models of a given theory, and structures are sets of objects with an interpretation linked to a vocabulary (Lutz, 2015) [21].

As it has just been described, theories are abstract structures that are made to relate to reality (the empirical content), through appropriate linguistic interpretations. This is also confirmed by Suppes (1964) [40]. who gives a more formalized sketch of a theory by asserting that it is composed of two parts: (I) the abstract logical calculus with primitive symbols (the theoretical terms referring to the unobservable phenomena) and stated axioms or postulates; and (ii) the set of rules that assign empirical content (interpretation or correspondence) to the primitive symbols of logical calculus.

Broadly speaking, a theory could be seen as a simplified explanation of reality or a phenomenon in the form of a set of statements, having a main purpose to explain and predict events, by stating relationships between concepts which are defined as variables (interrelated by one or more hypothetical or theoretical propositions), described in language through definitions (Watt and Van den Berg, 2002, pg. 1-4).

Since the debate between both received views, the older syntactic and the newer semantic conception (Azzouni, 2015), is not over yet as it is central in the discussion about the structure of scientific theories (Halvorson, 2015) [12]. we will not align ourselves not neither one but capture the essential features of both.

In more simple terms, we will define a theory as a collection of syntactic (or linguistic) and mathematical elements that try to link ideas with the reality of nature.

Whatever a theory is, two important facts are acknowledged by philosophy of science: the context of discovery of the theory (or how one arrives to the formulation of it), and the context of justification (of how a theory is shown to be closer to the truth than another).

## Scientific Progress: Theoretical and Empirical

It is a well-known fact that, slowly but surely as time passes, theories that are devised by scientists become increasingly better at predicting events and therefore are truer (or more verisimilar) than those that have been superseded. Verisimilitude is indeed a surrogate for the truth of scientific theories offered by Karl Popper as part of his vision of the nature of scientific progress (Bunnin and and Tsui-James, 2003, pg. 892).

The term scientific progress is quite confusing in philosophical terms as it has been attributed different meanings depending on the context. For Kuhn, whose revolutionary 1962 book set the stage to a whole new chapter in social philosophy of science, science passes through phases between paradigms (seen as different standards and rules for assessing theories and scientific work) without getting closer to the ideal or perfect one (Godfrey-Smith, 2003, pp. 94-95) [10]. So, in history, we should see the moving from one paradigm (or theory) to the next.

A theory can be seen a broader research program.

In the view of Lakatos, the research program has a hard core of principles forming the theoretical part of the theory supplemented by a continuously evolving protective belt of more specific and auxiliary assumptions, which will come into contact with the observational data of the experiment and that can be rationally modified in a progressive manner in order to generate new predictions, should the theory be at odds with some empirical result (Borchert, 2006, V5, pg. 171) [5].

As explained by Pagin (2006) and Musgrave and Pidgen (2016) [26, 25]. the sentences at the periphery have a more experiential character than those close to the hard core (T), being wholly theoretical, so that H1, as an auxiliary hypothesis, is more theoretic than H2, which has a more observational/empirical property, until they become completely observational data near the edge of the periphery. This is represented in Figure 1.

Figure 1 – Essential features of a theory structure according to Lakatos

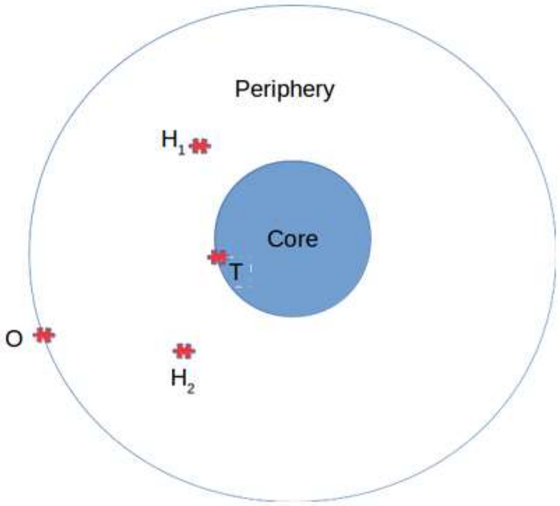

**Fig 1**

Therefore, there is an evolution in time of theories. This can be seen in Lakatos' historical sequences of theory versions where a theory or research program is composed by two parts, a framework (the very general theoretical hypothesis) and a protective belt (a combination of auxiliary hypotheses), and the periphery (or protective belt, which is a supplement to protect the hard core) of a theory T1 can be expanded, modified or contracted, as long as the core is unmodified (Alihosseini and Keshavarz, 2016) [1].

Thus we have the sequence C1V1 → C1V2 → C1V3, etc

Indeed, this is the 'Duhem–Quine thesis', according to which, any particular scientific theory can always be defended in the face of contrary observations by adjusting auxiliary hypotheses (Bunnin and Tsui-James, 2003, pg. 297-298)

In simple terms, in theory progress, according to Schurz (2014, pg. 281) [36]. the alteration of the theory core leads to a new research program and in history this can repeat itself any number of times as long as new theories are developed that better fit the experimental data. This is Kuhn's (Bird, 2012) [4]. Revolutionary phase.

So we will have:

$$C1V1 \rightarrow C1V2 \underline{\rightarrow} C2V1 \rightarrow C2V2 \underline{\rightarrow} C3V1 \ldots \text{etc}$$

Indeed Kuhn (1970, pg. 20) [16]. confirmed that the competition between segments of the scientific community is the only historical process that ever actually results in the rejection of one previously accepted theory or in the adoption of another.

Psillos and Curd (2008, pg. 255) [29]. also narrated how Lakatos sustained that there is an objective basis for choice between competing research programs, since a progressive program that successfully predicts novel facts is to be preferred to a degenerating one that fails to predict such facts.

There is only one objection here that can be raised. This is that, by continuously adding unverified and singularly unverifiable hypotheses to the theory being defended, the only corroboration of the added belief or assumption will come from the empirical success of the theory itself (and thus rely solely on the empirical data obtain by testing the theory and also on all co-joining hypotheses). This point is further developed in section 2.4.5 Commensurability of theories.

Nevertheless, it should be reminded what Kuhn (1970, pg. 144-145) [16]. himself said: the scientist, as long as he is engaged in normal science, is a solver of puzzles, not a tester of paradigms and that paradigm-testing occurs only after a persistent failure to solve a noteworthy puzzle has given rise to crisis.

## Scientific Methodology: Testing Theories

As we have just seen, the layman's view that observational propositions are simply a result of an experiment or a set of observations a scientist performs in order to confirm or refute a theory, is too simplistic. Franklin and Perovic (2015) recounted how Kuhn and Feyerabend vigorously criticized this view since observations and experimental results are already part of a theoretical framework and thus cannot confirm a theory independently.

Psillos and Curd (2008) [29]. distinguished several types of methodologies utilized in the sciences depending on the field of practice and on the historical time-period and cultural context. Among these were: data collection methods, experimental design techniques, and appraisal and evaluation of theories. On the latter we shall focus.

However, central to this idea is the concept of experimentation. Actually, an experiment often takes its importance from its relation to theory, as it may confirm a theory, refute a theory, or give hints to the mathematical structure of a theory (Franklin and Perovic, 2015)

Over the years, the scientific method has evolved as a highly formalized, systematic and controlled version of the innate human activity of collecting and summarizing information into naive theories (Watt and Van der Berg, 2002, pg. 3, 7-8, 37-38). Generally, all the major steps of a scientific study can be described as follows:

1. A scientist seeks out relevant constructs (causally related and theoretically linked concepts and meanings thereof), which vary,
2. observes their values (the indicators used to capture those meanings: operational definitions) and link them to functional statements (finding the relationship between concepts), ruling out alternative causes (confounding variables)
3. creates a theory which contains a testable prediction or hypothesis (withholding judgement about the truth or falsehood of a theory until we have been able to determine the extent to which predictions mirror observed reality), and
4. Collect limited evidence, in an unbiased way, to see if the predictions are probably correct in a general manner.

We shall now look at the consequences of this approach.

## Experiments: Verification and Falsification

Experiments must satisfy some common universal standards like validation of methods (instruments used) and good experimental design. While Kirk (1982, pg. 23-25) and (Vosloo, 2014, pp. 299-353) [14, 44]. set out the minimum criteria for a good experimental design and the appropriate techniques to analyse the different variables (independent, dependent and nuisance), Boque *et al*. (2002) illustrated how the performance capabilities of an instrument (method validation) is fit for purpose and which are the various techniques that make an analytical result (the instrumental outcome) reliable for the specified use. Among these, a very important aspect for the scientific method is the repeatability and reproducibility of the experiments. In fact, Vitek and Kabilera (2011) went so far as to state that independent verification of a scientific hypothesis through the reproduction of experiments by an autonomous researcher/lab is at the very core of the scientific method. In a more general sense, Cassey and Blackburn (2006) distinguished repeatability from reproducibility by providing opportune raw data in a publication (thus making it reproducible), and by supplying methodological/analytical protocols for a comparison of the results (making this repeatable by others). Therefore, a suitably organized research design is viewed as the functional plan in which certain research methods and procedures are linked together to hypotheses so as to acquire a reliable and valid body of data (evidence) for empirically grounded analyses, conclusions and theory formulation (Vosloo, 2014, pg. 316) [44]. According to Bogen (2017) [6]. the hypothetico-Deductive (HD) method utilizes observational evidence to argue for the truth of theories whose deductive consequences it verifies, and against those whose consequences it falsifies. The concept of verifiability, according to the positivists, is based on a minimum necessity of a theoretical sentence to be verifiable, to be meaningful, and it has to bear a positive result. The critique of verificationism has brought falsificationism, which says that a theory can only be corroborated (the testability of theories: the demarcation of science). Thus, Popper tried to embed falsifiability (the criterion by which the other rules of scientific procedure must be designed in such a way that they do not protect any statement in science against falsification) in a normative methodology by prohibiting any ad hoc reformulation of a theory to meet contradictory evidence (Sarkar and Pfeifer, 2006, pg. 574) [35]. Again, according to Popper, science is, in reality, deductive: starting from a hypotheses, through the making of calculations to obtain a prediction that can then be falsified or not (corroboration) deductively, although later he blurred the distinction between falsifiable and not falsifiable, and instead started speaking of degrees of testability (Andersen and Hepburn, 2015) [2]. But it must be borne in mind that experimentation has its problems. As listed by Franklin and Perovic (2015), there are several instances where experiments are theoretically difficult to explain, apart from theory-ladenness of observation and experimental results, which nonetheless remain robust. Such cases, among others, are: Galison's elaboration on experiments; Collins' experimenters' regress; Pickering's plastic resources and communal opportunism; and Hacking's social construction of experiments.

We shall now turn to probability theory and its impact on scientific theories.

## Probability

What is the nature of the theory of probability (the correct mathematical kind) is a question central to the philosophy of probability, as this science is extensively used in every branch of sience and outside of science too, like game playing and decision making (Lyon, 2010) [22].

Probability is defined by Machin *et al*. (2007, pg. 46) [23]. in three ways: in terms of either the long-term frequency of events, or as model based or as a subjective measure of the certainty of an event happening.

In the description of Sarkar and Pfeifer (2006, pg. 41-42) [35]. Thomas Bayes initiated a very acute mathematical analysis of inductive reasoning, based on his famous rule for updating a posterior probability assignment, in order to provide an explanation of how probabilities depend as much on the background information as on the data obtained.

Indeed, Bayes's theorem states, as taken from Bunnin and Tsui-James (2003, pg. 291):

$$\text{Prob}(H/E) = \text{Prob}(H) \times \text{Prob}(E/H)/\text{Prob}(E)$$

Where H is some hypothesis, and E is some newly discovered evidence.

It is said, hence, that it is possible to adjust the prior degree of belief in H in line with the right-hand side of the above equation to the extent that E is likely, given H, but unlikely otherwise (subjective degree of belief).

The Bayesian method allows us to view the data impact on the epistemic attitudes towards statistical hypotheses (H), in terms of subjective posterior probability assignment, but still meeting certain objective criteria of rationality, coherence, and calibration (Romeijn, 2014) [32].

Therefore, Bayes's rule is extremely helpful in computing the probabilities of various assumptions (H1, H2, Hn) that may result in an event E (Spiegel and Stephens, 2014, pg. 170) [39].

In the words of Machin *et al*. (2007, pg. 53) [23]. Bayes' theorem has a predictive value enabling prior assessment concerning the chances or the odds of a hypothesis to be combined with the test results of the experiment E to obtain an a posteriori assessment about the validity of the assumption.

Actually, saying that the probability distribution of an outcome variable (the data) depends on model parameters is like confirming that the conditional probability of the observed data given model parameters (Kirkwood and Sterne, 2010, pg. 388) [15].

Thus, as a theory of inference, the Bayesian approach is useful in recalculating the degree of belief in an hypothesis under examination when confronted with new data, although many critics have concluded that, in the face of new evidence, it is inadequate as a theory of evidential support in scientific contexts (Losee, 2001, pg. 221-226) [20]. This occurs because the evidence antecedently known is not taken into account whilst calculating the prior belief for a hypothesis.

## Commensurability of Theories

Contrary to the belief of incommensurability of different paradigms or scientific theories, that are equally empirically successful (problematized independently by Thomas S. Kuhn and Paul Feyerabend in the 1950s and 60s), since observational concepts in both theories differ and scientific research methods and standards of evaluation change (Reiss and Sprenger, 2014) [31]. it is generally believed that a minimal amount of theory dependence, in the form of simple observable phenomena, which do not depend on anything contentious, should be used to decide in favor or against a theory (i.e., settle scientific disputes).

This position is defended by Schurz (2009) [37]. as a minimal realism, where an outdated theory T1 satisfying the requirements of

- producing novel predictions, which at the time of the theory construction were neither known, nor expected; and
- having strong empirical success, yielded by one (or several) theoretical terms or expressions of T1;

Contain a (theoretico-structural) content-part which is indirectly true and hence partially true (since 'indirect truth' is an important case of 'partial truth'), given the approximate realistic truth of the currently accepted theory T2. But this has rarely worked out in real life in science.

So, there must be a more comprehensive and assured way to resolve the issue at stake.

Hence, to really decide for a theory we should devise a strategy to tackle the problem from the inside of the theoretical structure.

An initial example of this kind of approach was proposed by Balashov (1994) [3]. as an antiholistic account of scientific tests with the introduction of inferential and conjunctive elements in a string of testing procedure from the core to the outer layer of the periphery of the theoretical structure.

Based on this and Lakatos' interpretation (Musgrave and Pidgen, 2016) [25]. each element of the testing procedure (the inferential chain) is directly or indirectly linked to the main core hypothesis as conjuncts as shown in Figure 2.

Figure 2 – Structure of theory testing of theory T, loosely taken from Balashov (1994) [3].

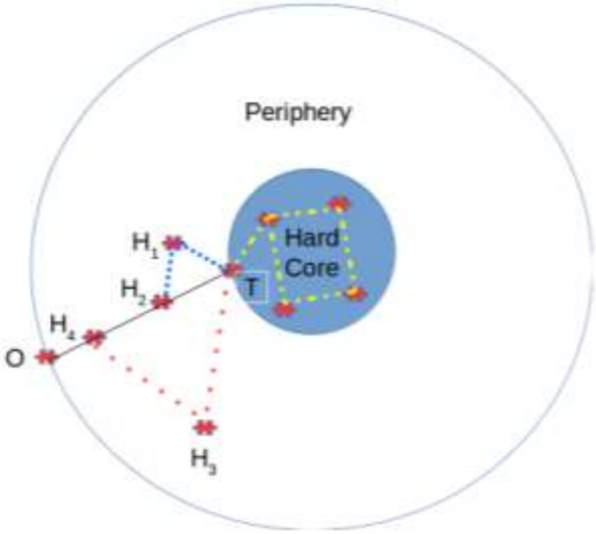

**Fig 2**

These elements in the periphery are auxiliary hypotheses or background beliefs (H), which, having either an instrumental, or interpretative function, are linked in a string pattern between themselves, and are seen as essential to the testing procedure in order to verify the empirical content (O) on the edge of the periphery of the Theory T, as also noted by Quine (1951) [30].

The variable T on the border of the core is fundamental for the correlation between theoretical and empirical content (as a model of computation/prediction).

This simplified view of a string of test procedure as shown in Figure 2, is explained as follows: in order to test a prediction O of the theory T the four conditions H1, H4 are needed to set up the testing procedure that will be used to measure the outcome of O.

When a research program utilizes several unproven assumptions, even if these have been acquired in the former versions of that same core theory or if they have been generated in predecessor theories altogether but have never been individually confirmed (resulting in highly probably true premises), these may be regarded (by the current scientific establishment) presumably confirmed but are not so, in reality. Actually, they retain the original degree of probability conferring this degree to the current theory, as a whole or at least to corroborative nature of the single observation (experiment) being performed. And because of the nature of the testing is in the form of conjunctions of premises (T ∧ H1 ∧H2 ∧ Hn), the resulting probability of the observation O corroborating the theory T is the product of the single probabilities by the axiom of joint occurrence (as detailed in Salmon, 1999, pg. 67-68) [34].

Finally, other proposed criteria used to assess desirability of scientific theories (Smeenk and Ellis, 2017) [38]. include:

1. The ability to unify diverse phenomena, taken as part of what constitutes empirical success
2. explanatory power,
3. consistency with other theories; and
4. Other factors.

## Theoretical Assessment Plan: Ili and Icih

Now, in the face of continuously re-shifting of assumptions and auxiliary conditions to save the core of a theory, how can we compare two theories?

The answer is quite radical. A plan is needed. This will be called Theoretical Assessment Plan (TAP).

The first part consists in a two-step process that has to be developed to evaluate the consistency of the hypotheses.

Critical reasoning is fundamental in this process. The first step consists in identifying whether within such auxiliary hypotheses there is a logical fallacy of any kind.

In the strict sense, a fallacy is an invalid form or argument, an unsoundness in reasoning starting from the premises and arriving to a conclusion (Borchert, 2006, V3, pg. 537) [5]. One example would be to prove that there is a circular reasoning of unverifiability. That is, whether the singular hypotheses have been verified independently (or with minimum subsuming conjunctive hypotheses) or if they are bound together by an inconsistent group-sustaining verification process: i.e., H1 verifies H2 which sustains H3 which corroborates H4 that may then verify H1.

This process, the Identification of Logical Inconsistency (ILI), can be done with critical reasoning, without any need for experimentation. This could happen quite often due to the incumbent non-omniscience of any single scientist or group of scientists in any particular area of study, at any specific point in time.

And, it is even worse if these group sustained assumptions are incorporated in the core of a theory, since at this point the theory loses credibility.

Hence, we should look at internal circular verification of hypotheses: as a result of this, we come to realize that bootstrapping is not a sustainable method for confirmation because there is a risk of incurring in serious logical errors of unsound reasoning, like circularity (Crupi, 2015) [9].

The second step requires experimentation to be performed for each hypothesis has to be individually reviewed, and if possible, independently verified. This step, the Independent Confirmation of Individual Hypotheses (ICIH), may be performed in different ways, but all of them require appropriately set up experimental designs and multiple analytical evaluations: cross-verification in the intra-theoretical sense of Balashov (1994) [3]. and inter-theoretical cross-verifications are just some technique examples.

The second part requires both the evidence E to be evaluated or tested through multiple analytical techniques using the standards of method validation as detailed in Boque *et al*. (2002), and the empirical research design to be appropriately set up for the hypotheses to be tested, according to the principles outlined by Kirk (1982) and Vosloo (2014, 313-350) [14, 44].

We are able now to draft a tentative methodological approach to evaluate incommensurable theories based on an holistic testing schema called TAP (theoretical assessment plan).

Hence, between two equally empirically successful theories (research programs) the choice should always fall on the one that has:

1. less logically circular reasoned group-sustained assumptions or hypotheses;
2. less irreducibly bound core hypotheses;
3. more independently evaluated experimental results (using different techniques with less theoretical impact – i.e., from distantly related fields of science, if possible);
4. more independently confirmed assumptions or hypotheses;
5. more testable hypotheses (through observations and experiments);
6. more laboratory tested hypotheses (experimental designs) or evidence with respect to observational only study designs (as detailed in Hoppe *et al*., 2009);

   The result of this analysis will yield the more probable theory between the two, in the Bayesian sense.

## Parallel Development, Theory Surpass and Overtake

Papineau (1997) [27]. has already raised the issue regarding the likelihood of accepting a theory into the mainstream academic mindset when declaring that one striking feature of philosophy of science over the last three decades has been the currency given to extreme relativist views about theory-choice. The author further expands the concept stating that since choices between alternative scientific theories are never conclusively dictated by any finite body of experimental evidence, they must instead rest on non-rational grounds (i.e., on some hunch or arbitrary decision).

This kind of relativism about theory choice is not orthodoxy among contemporary philosophers of science, but it is the dominant view among historians and sociologists of science.

Looking at the history of radical theory change in science, there is a well-known argument against realism, although not necessarily the most compelling of them: the notorious pessimistic meta-induction. According to this view, the reflection on the abandonment of theories in the history of science motivates the expectation that our best current scientific theories will themselves be abandoned, and hence that we ought not to assent to them (Ladyman, 2014) [17].

Any disagreement will have to result in careful scrutiny of the method used or in the revision of the original theory (Watt and Van Den Berg, 2002, pg. 9).

In history, it could occur that the scientific community acceptance of an empirical theory progress (the transition from C1V1 to C2V1) was dictated by any means at the time of the transition, a thought agreed upon by Laudan and Leplin (1991) [18].

But that the former theory program could evolve in the background independently. This would lead to a parallel development or evolution of the previous paradigm (not in the static sense of Kuhn's but in the more dynamic sense of Lakatos), where the eCP could have been modified or added to obtain further theory versions that better fit the data and experience.

This is visually summarized as follows:

→ C2V1 → C2V2 → C3V1 → C3V2 → C4Vn
C1V1
→ C1V2 → C1V3 …. → C1Vn

Where n is a positive integer number different from 0.

The net result is that, in any specified time, we could have a larger scientific community that holds to a generally accepted scientific research program (phases C2, C3 and C4) while contemporaneously a smaller scientific community is developing the previous research program through a sequence of non-degenerative theory versions (sequence V1, V2, V3 and Vn, etc.).

This period of parallel development can be quite long. One example in history of science is the parallel development of the heliocentric theory lasting almost 2 millennia, since its conception by the Greeks. Furthermore, it is historically possible that at a certain point in time a theory surpass may occur. A theory surpass of T1 (C1Vn) with respect to the currently accepted T2 (C4Vn, as outlined above) is when the empirical prediction of the previously rejected T1 is more successfully empirically confirmed (or the theory version T1 has a higher empirical success) than T2. Thus, T1 is now in a state of rational acceptability, according to Schurz (2014, pg. 288) [36]. because it is empirically confirmed (although not equal, but superior to T2), albeit it may not yet be simultaneously accepted since the other theory T2 better fits the currently accepted theory net. This state of affairs is when the larger scientific community does not realize (for any reason) the potential of T1 and its superior empirical success. An example, limited to a hypothesis, is the revolutionary vision of Thomas Digges (c.1546-1595) about an infinite universe of stars like the Sun, being the first Renaissance writer to propose a physically infinite universe. And restoring the earlier Epicurean-Lucretian cosmology (Usher, 1997). Finally, although the probability of occurrence is very low, and presently never happened in the history of science, it is still possible that the theory version T1 becomes accepted and even substitutes T2. Of course, we have a special occurrence of the revolutionary phase outlined by Kuhn (1970, pg. 149-151) [16]. this theory overtake is bound to be the most radical event in the history of science as the theory version T1 cannot possibly fit the so long developed theory web and possibly shattering the closest fitting theories in the net.

## Alternative Theory Nets or Lattices

As it is known that sometimes several theories compete for the place of the best scientific account of the world and that the practice of normal, everyday science is guided by the paradigm, which sets the community standards, reigning at the the specific point in time (Reiss and Sprenger, 2014) [31]. it is often difficult to decide between competing theories. This results from the demands that scientists require their theories to have what is more than mere compatibility with some set of observational claims: they must fit into a larger explanatory scheme, and be compatible with other successful theories (Smeenk and Ellis, 2017) [38]. So, if the status quo is that a theory Tj is well fitted into a net of other compatible theories, which are considered successful in other areas of science, it is logical to suppose that a rival theory Ti would most likely not be able to fit into this web or lattice of theories. The accepted theory net is the standard official cumulative human knowledge at any point in history.

Is it possible that distinct secondary scientific communities (whereby scientific community we consider scientists that do science and that apply theoretic knowledge to empirical phenomena), which are occupied in developing and testing 'superseded' theories, conjoining new eCP based on novel facts and experiments, as time progresses, are not yet realizing that they are contributing to a new and alternative theory net made up of the various disciplines being studied?

The existence of such alternative theory lattices is a fact in history. Whether these are rightfully considered scientific is debatable altogether. But as briefly highlighted and as depicted by Clifton *et al.* (2012) [8]. concerning several work-in-progress theories of gravity, it is nevertheless a fact that, in the history of science, co-evolving theories try to make their way in the theory net as better alternatives of the reigning theory. Moreover, completely different theories, as the electric nature of the universe, originally developed in the late 19th century, could be an alternative to the presently accepted big picture of the natural world (as made up of subatomic physics to life sciences), which has progressively excluded uncomfortable facts and counter-arguments (Thornhill and Talbott, 2007, pg. 1) [42]. And this may well merge with other alternative theories in other areas of science (not just physics), creating and establishing a respectable and perfectly scientific view of the world (a new or alternate theory net) in opposition to the 'standard' one.

Finally, it could also occur that two or more different but not opposing theory nets could co-exist, both or all being founded apparently on proper science. One of these will obviously be the socially approved theory net (by the scientific elite of the time) while the other(s) will have their own community of scientists and developers moving through time in parallel with the principal, accepted (world) view.

## Conclusions

The philosophy of science has shown us that theories are no simple entities. They explain and try to predict future and past events based on evidence and inductive/deductive reasoning. The explanatory and predictive power of scientific theories are the virtues that scientists use to choose a theory over its competitors. Other things being equal, scientists choose T1 over T2, if T1 has higher explanatory power or predictive power than T2 (Park, 2017) [28].

Although it has been related that scientific theories are incommensurable, it is always possible to investigate in detail which theory has more unfounded core or periphery hypotheses. In the light of the fact that no conclusive disproof of a theory can ever be produced (Sarkar and Pfeifer, 2006, pg. 274) [35]. the only possible conclusion for a scientific comparison of two opposite views is the probabilistic approach of Bayes. This results necessarily in the accommodation of antecedently known evidence (as all data should be included at the time of the prior assignment of probability), towards the sum of instances of confirmation/disconfirmation the two theories, through an elaborated and comprehensive TAP.

Yet, as just mentioned, two or more systems of scientific thought can coexist in opposition or not amongst themselves in different scientific communities.

Another example of this could be the existence (or coexistence) of medical world views such as modern western medicine (biomedicine) and traditional Chinese medicine (TCM), both officially approved in China (Hai, 2009) [11]. While based on different concepts, the two medicines share some common grounds that allow them to be commensurable. Similarly, other worldviews exist in the same area of medicine which are more akin to TCM than to modern biomedicine (Menapace, 2019) [24]. Again, the principal theory net is the socially accepted and major community approved, Western medicine, but growing communities of alternative and also opposing theory nets are emerging which one day challenge the authority of the now deemed standard may view. This is all but normal, as history often repeats itself with some extra twists. Nonetheless an additional way to commensurably weigh theories and, consequently, their theory lattices, has been proposed. TAP can probe theories at the level of core and periphery hypotheses and identify their testability. TAP may indeed facilitate, once applied, this investigation into the truthfulness of current theories and reveal which are founded on less sustainable hypotheses and which are not. All this may lead us to a theory surpass or overtake.

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